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The Miocene of Northern Costa Rica

WITH NOTES ON ITS GENERAL STRATIGRAPHIC RELATIONS

BY

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Genus **NUCULA** Lamarck

Nucula orbicella, n. sp. Plate 28, figures 19, 20

Shell of medium size, broadly elliptical or subovate in outlines; obliquely truncated at its anterior end; gently convex; the surface is covered with close, subregular, concentric wrinkles and fine radial threads so that the sculpture is decussated; on the posterior dorsal slope, they are larger and pustular-like and their course is obliquely downward across the growth-lines; they are weak on the poorly defined lunule; the radical threads are mainly between the concentric wrinkles but ventrally they cut into the wrinkles as well; interior of the shell, silvery white or faintly tinged with purple; the ventral margin is finely crenulated; chondrophore very small, oblique; anterior set containtng about 8 teeth, the posterior with about 17.

Length	height	semi-diameter
9.50	7.50	2.25 mm.
11.00	8.50	2.50 mm.

From the recent *N. crenulata* A. Adams, this shell differs by its larger size and more elliptical and depressed shell. Gabb has described from the Pliocene of the Limon Peninsula *Nucula limonensis* and *moenensis*, but both of these species are perfectly smooth and sculptureless. The *Nucula orbicella* is a common species in certain marly beds intercalated in the coralline limestones of Port Limon.

Gatun Stage: Port Limon.

Nucula cahuitensis, n. sp. Plate 18, figures 21-24

Shell small, solid, obliquely subtrigonal in form; ventral margin widely rounded, a nearly straight posterior dorsal margin and a widely truncated anterior end; valves gently convex; protoconch on the tip of the umbo small, smooth and white; surface polished; the sculpture of the disk of the shell is developed to a variable extent, but the umbos are always smooth; typically the lower half of the shell is covered with close, regular, concentric wrinkles which are slightly decussated by fine, even, and slightly raised radial threads; in other cases, the wrinkles may be present only on the extreme anterior or posterior ventral extremities and the radial lines showing only as a part of the shell substance and not as raised threads; the escutcheon is elliptical and thickly covered with raised wrinkles which lie at right angles to the dorsal margin of the shell; they are similiar on the lunule; interior of the shell tinted with brown; ventral margin crenulated; chondrophore small, oblique with the anterior set of teeth numbering about 7, the posterior about 14.

Length 3.50, height 3.00, diameter 1.60 mm.

This is a small species of subtrigonal outlines, suggestive of the Pacific *N. exigua* Sowerby in general form and size. On the few specimens of *N. exigua*, which I have from the Bay of Panama the sculpture is finely decussated over the whole shell with fine radial and concentric threads. The most striking features of *cahuitensis* are its strongly sculpture lunule and escutcheon.

Gatun Stage: Zone G, Saury Creek.

Nucula tenuisculpta Gabb Plate 18, figure 25

Nulua tenuisculpta Gabb, 1873, Trans. Amer. Phil. Soc., vol. 15, p. 255.

Nucula tenuisculpta Maury, 1917, Bull. Amer. Pal., vol. 5, p. 325, pl. 26, figure 8.

A species of the size and form of *cahuitensis* but the valves are entirely smooth and polished. The lines of growth are fine and irregular. The radial lines are faint and sub-microscopic. Inner margin crenulated.

Height 3.25, length 4.00, semidiameter .75 mm.

Gatun Stage: Coll 4, Red Cliff Creek.

Genus **LEDA** Schumacher

Leda Balboae Prown and Pilsbry Plate 18, figure 15

Leda Balboæ Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. Phila., vol. 63, p. 362, pl. 27, fig. 8.

This species is fairly common in Costa Rica, but generally smaller than in the Canal Zone, where it frequently reaches a length of 22 mm or more. Its valves are moderately convex and regularly sculptured with even, close, concentric riblets which on the center of the shell disk may be slightly appressed. The escutcheon is well-defined and similiarly sculptured with the riblets running parallel to the hinge margin.

Gatun Stage: Gatun, C. Z.
Coll. 1, East Grape Point Creek.
Zome G, Saury Creek.
Quitana Creek.
Hill No. 3, Banana River.

Leda Davilae, n. sp. Plate 18, figure 20

Shell small, solid, strongly convex; the beaks nearly central; the rostrum is short, pointed and sharply defined from the rest of the shell disk by a high, cord-like ridge; the anterior end is bluntly rounded and carries 2, low flexures from the beaks to the anterior ventral extremity; lunule small and narow, lacking the concentric ribs and sculptured with small, pustular-like ridges passing at right angles to the hinge-line; the sculpture consists of about 30 concentric riblets which are somewhat larger and with deeper interspaces on the umbos; the interspaces show on the umbos and along the anterior slope, fine, radial lines or punctations; interior of the shell cavity deep, with a heavy hinge; the anterior and posterior sets of teeth number about 13 or 14, are high and V-shaped.

Length 5.75, height 4.00, semi-diameter 1.75 mm.

A small, plump species, coarsely sculptured with even, concentric riblets, separated by deep interspaces. These interspaces may carry fine, radial lines or punctations at the base of the concentric ribs and are best seen on the umbones and the anterior slope. The *L. indigina* Dall (*L. bisulcata* Guppy) from the Miocene of Jamaica is similiar but proportionately longer.

Gatun Stage: Coll. 4, Red Cliff Creek.
Bocas Island.

Subgenus **ADRANA**, H. and A. Adams

Leda quitanensis, n. sp. Plate 18, figure 19

Shell thin, elongate but slightly convex; beaks very low and scarcely distinguishable from above and situated at the anterior 1-3; ventral margin an even curve from the pointed extremities; dorsal margin straight; surface polished but covered with very fine, concentric lines which are crossed on the lower half of the anterior 2-3, by even, oblique lines (*Scissula*-like); these oblique lines are spaced about .25 mm apart; interior concealed.

Height 7.25, lenght 26.00, semidiameter .75 mm.

A much smaller species than the next (*ensinoides*), slightly more convex and with beaks situated more anteriorly. The surface is finely sculptured about the middle and the anterior portion by slightly oblique lines, as seen on certain Tellinoids such as *Scissula*. The Manzanilla beds of Trinidad contain *Leda* (*Adrana*) *Guppyi* Dall (*Cercomya ledæformis* Guppy). It is less elongate, more contracted posteriorly and has a different surface sculpture. Dall has also recorded *Leda Guppyi* from the Bowden beds of Jamaica.

Gatun Stage: Quitana Creek.
Zone F, Saury Creek.
Coll. 1, East Grape Point Creek.

Leda ensinoides, n. sp. Plate 18, figure 12

Shell rather large, elongate, depressed and subequilateral;

beaks very small and scarcely distinguishable from above, and situated nearly about the middle of the dorsal margin; extremities bluntly rounded, with a broad, even curve to its base or ventral margin; the dorsal side is nearly straight but descending slightly towards its extremities; surface nearly smooth, the growth lines indistinct, but with fine, even very slightly oblique lines on the anterior two-thirds of the shell; interior concealed.

Length 54.00, height 15.00, diameter 4.50 mm.

Differs from the preceding species by its larger size, nearly central beaks and by its finer, more concentric sculpture. There are several species of this group recent in the West Indies and along the Pacific coast of Central America, but none appear at all closely related to the Gatun species.

Gatun Stage: Hill No. 3, Banana River.

Leda Dalliana, n. sp. Plate 28, figure 17

Adrana sp ? Dall, 1898, Trans. Wagner Free Inst. Sci., vol. 3, pt. 1 4, p. 592.

Shell small, thin, elongate, depressed; the small, scarcely differentiated beak is sutuated about the anterior one-fourth of the shell; the anterior side is somewhat contracted and shortly rounded while the posterior side is produced and 3 times the length of the anterior and bluntly pointed at its extremity; the rostrum is long and narrow, formed by 2 radial, scabrous threads, separated by a wide interspace; concentric sculpture of thin, elevated threads or lamellae, regularly distributed on the lower half of the shell, but widely spaced on the umbonal area; the escutcheon is long and narrow, sculptured with threads parallel to the hinge-margin; interior of shell cavity shallow, the long hinge with an anterior set of 20 small teeth, the posterior with 26 or 27.

Length 10.50, height 3.50, diameter of left valve .75 mm.

A much smaller species than the preceding and differing in its more anterior beaks, depressed shell and heavier concentric sculpture as well as in other characters. It is probably the shell which Dall refers to as having fragments of from the Pliocene of Limon. But a single perfect specimen was collected

Gatun Stage; Port Limon.

Genus **YOLDIA** Moller

Yoldia bocasensis, Plate 28, figures 21, 22

Shell small, thin, ovate-elliptical in form; beaks situated slightly in front of the middle; valves moderately convex; both the anterior and posterior extremities are broadly rounded and connected by the gentle curve of the basal or ventral margin; the umbos are very small but distinct and lie just above the greatest convexity of the valves; surface smooth, polished with no other sculpture than the incremental growth-lines; chondrophore distinct, scarsely oblique and bordered on each side by an equal number of V-shaped hinge-teeth; the anterior set contains about 14 teeth, which are very small next to the chondrophore becoming progressively larger distally, the posterior set with 13 or 14; the pallial sinus is indistinct, but rather large, broad and extends nearly to the middle of the valve.

Length 13.00,	height 7.00,	semidiameter 2.25 mm.
9.50	5.50	1.50 mm.

A fairly common species in the clay beds of Bocas Island where it is associated with a fauna of rather deep water character. It has much the form of certain deep-water *Yoldiella* but the interior of the valves show an indistinct but deep and wide pallial sinus.

Gabb has described from the Miocene of Santo Domingo, a *Yoldia ovalis*, which has never been figured and its description is very meager and insufficient.

Gatun Stage: Bocas del Toro.

Genus **LIMOPSIS** Sassi

Limopsis monilis, n. sp. Plate 26, figures 23, 24

Shell small, solid, moderately convex and subcircular in form but slightly oblique; the hinge-line is straight, the anterior dorsal submargin very small, the posterior large undifferentiated from the rest of the shell ; the umbos are high and prominent, lying a little in front of the middle; exterior sculptured with strong radial ribs which are largest and strongest on the middle of the shell disk, finer on the dorsal submargins; these ribs are crossed by high widely spaced concentric lamellae, more closely spaced on the umbos; the lamellæ on crossing the ribs are raised into short, spine-like fringes which are directed ventrally; interior of shell deep; the hinge-line with a small cartilage pit at the anterior 1-3 of the shell; it is bordered on the anterior side by a set of 3 high, projecting teeth and 4 on the posterior side, the ventral and a part of the anterior margin is crenulated, most finely in the middle and quite coarsely at the posterior portion.

Length 1.75, height 2.00, semidiameter .60 mm.

This is a small, subcircular species with a crenulated inner margin and a strong surface sculpture of ribs crossed by distant concentric fringes. It is fairly common at its type locality, given below.

Gatun Stage: Old Man Sam Creek, 1 mile south of beach (A. C. Veatch, collector).

Genus **GLYCYMERIS,** Da Costa

Glycymeris canalis Brown and Pilsbry Plate 18, figures 2-7

Glycymeris canalis Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. Phila., vol. 63, p. 364, pl. 28, fig. 10.

Glycymeris trilobicostata Pilsbry and Brown, 1917, Proc. Acad. Nat. Sci. Phila.

Very abundant locally in the Gatun beds of Costa Rica, are small and medium sized Pectunculids belonging to the group of

G. acuticostata Sowerby of the Santo Dominican Miocene. They vary somewhat in size, (20 to 32 mm in height), are usually depressed and with an outline suggestive of the recent East Coast and Upper Miocene *G. pectinata* Gmelin. Typical *acuticostata* does not seem to occur in Costa Rica and I have adopted Brown and Pilsbry name of *canalis*.

The *G. canalis* Brown and Pilsbry from the Canal Zone, and the *trilobicostata* Pilsbry and Brown from Colombia, are both based on young shells 15 mm or less in height. Both forms can be duplicated amongst the Costa Rican shells and are but varieties of the same species.

In its usual and more abundant form, the shell is depressed, with numerous (about 26), closely spaced rounded or angled ribs. These ribs are overrun by even, close, concentric threads. They represent the usual *canalis* or its variety *trilobicostata*, and average in height about 25 mm. More rarely, the shells are larger and as illustrated by figure 4 and 5 the ribs may become divided into 2 or 3, strong, radial cords. The following measurements will show the usual range in size.

Height 22,	diameter 21,	thickness 5.5
24	23	5.5
32	32	8
29	29	8

Gatun Stage: Gatun, C. Z.
Comadre; Banana River; Coll. 4 East Grape Point Creek.
Old Man Sam Creek, C. R.

Glycymeris jamaicensis Dall Plate 19, figures 3, 4

Pectunculus pennaceus Guppy, 1866, Quart. Journ. Geol. Soc. London, vol. 22, p, 293. Not of Lamarck.

Axinea pennacea Gabb, 1873, Trans. Amer. Phil. Soc., vol. 15, p. 255.

Pectunculus decussatus Guppy, 1876, Qart. Journ. Geol, Soc. London, vol. 32, p. 532. Not of Linné.

Glycymeris jamaicensis Dall, 1898, Trans. Wagner Free Inst., Sci., vol. 3, pt. 4, p. 608.

Glycymeris jamaicensis Maury, 1917, Bull. Amer. Pal., vol. 5, p. 345, pl. 26, fig. 13.

This large Pectunculid, externally resembles in its angular posterior side the *Glycymeris pennacea* with which it was confused by Guppy and by Gabb. It differs in being somewhat less convex, less strongly sculptured and most importantly in its central beaks, located about the middle of the ligamental area. It is, on the other hand, much more closely allied with the recent West Indian *G. undatus* Linné (*G. lineatus* Reeves) of which it is doubteless the Miocene ancestral form, the main difference being in details of its finer sculpture.

The *Glycymeris jamaicensis* occurs in the Miocene of Jamaica and Santo Domingo but there never seems to reach the large size that the species sometimes attains in Costa Rican. A large shell in our collection from Old Man Sam Creek measures as follows:

Height 60, lenght 60, diameter of both valves 37 mm.

Gatun Stage: Water Cay.
Coll. 5, Red Cliff Creek.
Coll. 4a, East Grape Point Creek.
Colls. 5, 6, Old Man Sam Creek.
Sousi Creek of Upper Hone Creek.

Glycymeris carbasina Brown and Pilsbry Plate 19, figures 1, 2, 5

Glycymeris carbasina Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. Phila., vol. 63, p. 363, pl. 28, fig. 9.

The *Glycymeris carbasina* was described by Brown and Pilsbry from a small individual from Gatun, measuring only 16 mm in height. It is closely related to the *G. jamaicensis* Dall and probably represents but a varietal form. Its main differences is its more circular and less convex shell, and less number of hinge-teeth which number about 10 to 12 on the anterior and posterior sides respectively.

All our specimens were collected in the lower Gatun of E. Grape Pt., Cliff Creek in Eastern Costa Rica, the largest shell measuring as follows:

Height 56, length 55, diameter of both valves 32 mm.

Gatun Stage: Coll. 4, East Grape Point.

Glycymeris castaneus Lamarck Plate 18, figures 13, 14

Pectunculus castaneus Lamarck, 1819, Anim. sans Vert., vol. 6, p 53.

Pectunculus castaneus Reeve, 1843, Conch. Icon., *Pectunculus* pl. 6, fig. 32.

Our collection from the Banana River contains several small Pectunculids which differ from the *jamaicensis* and its allies by their less circular shell, greater convexity and coarser radial sculpture. These shells agree however very closely with a recent species which is abundant on the beaches of northern Costa Rica, which appears to be the *Glycymeris castaneus* of Lamarck. *Glycymeris castaneus* is distinct from *undutus* Linné (*G. lineatus* Reeve) with which it is sometimes united, differing by its form which is more produced posteriorly but not angulated and by its more pronounced radial costæ. Both species are similiarly colored with chestnut markings.

Gatun Stage: Hill No. 3, Banana River.
Quitana creek.

Glycymeris decussatus Linnæus Plate 19, figures 6, 7

Arca decussatus Linnæus, 1758, Syst. Nat., ed. 10, p. 694.

Pectunculus pennacea Lamarck, 1819, An. s. Vert., vol. 6, p. 51.

Pectunculus pennacea Reeve, 1843, Conch. Icon., *Pectunculus*, pl. 5, fig. 24.

Pectunculus decussatus Linné. *P. pennaceus* Lamarck, (Lamy) 1911, Journ. de Conchy., vol. 59, p. 119, pl. 3, fig. 7.

Of this rare shell, more commonly known as the *G. pennacea* Lamarck we have several excellent specimens collected by

Dr. A. C. Veatch from the Upper Gatun of Old Man Sam Creek in eastern Costa Rica and a few specimens from the coral-reef limestones of Port Limon. Although a very distinct species and not to be confused with any other Pectunculid recent or fossil, its characters have been generally misunderstood and its name has often been applied to shells of the *G. lineatus* group.

The shell is of moderate size, strongly convex and inequilateral. The beaks are slightly posterior of the middle, with the ligamental area entirely anterior to the beaks as seen in figure 7. The surface is sculptured with numerous, moderately coarse, radiating threads which are simple on the umbonal area but become divided by 3 or more finer threads ventrally.

Gatun Stage: Old Man Sam creek.
Port Limon.

Glycymeris Lloydsmithi Pilsbry and Brown Plate 25, figures 8. 9, 10

Glycymeris Lloydsmithi Pilsbry and Brown, 1917, Proc. Acad. Nat. Sci. Phila., vol. 59, p. 39, pl. 6, fig. 6.

This is an abundant fossil in eastern Costa Rica, where it frequently forms zones in the lower and middle Gatun. Its type of sculpture of broad, smooth, rounded ribs, is strikingly like that of *G. subovata* Say of the Miocene of eastern United States. It differs in its higher and narrower umbos and by its nearly smooth cardinal area.

The *G.Lloydsmithi* was described by Pilsbry and Brown, from beds equivalent to the Gatun, near Cartagina, Colombia.

Gatun Stage: Zone 3, East Grape Point Creek, C. R.
Coll. 5, Red Cliff Creek, C. R.
Headwater of Middle Creek, C. R.

Genus **ARCA** Linnæus

Arca occidentalis Philippi Plate 22, figure 1

Arca occidentalis Philippi, 1847, Abbild. u. Beschr., 3, p. 14, pl. 17b, fig. 4a-c.

Arca noœ Guppy, Journ. Geol Soc. London., vol. 22, p. 293.
Arca occidentalis Sheldon, 1916, Paleont. Amer., vol. 1, p. 8, pl. 1, figs. 8-11.
Arca occidentalis Maury, 1917, Bull. Amer. Pal. vol. 5, p. 327, pl. 29, fig. 3.

This is a common recent species of the West Indian and Caribbean fauna. As a Miocene fossil it is found in Jamaica and Santo Domingo and it is here recorded from the Miocene of Costa Rica.

Gatun Stage: Port Limon.

Arca umbonata Lamarck Plate 22, figure 2

Arca umbonata Lamarck, 1819, An. s. Vert., vol. 6, p. 37.
Arca imbricata Gabb, 1873, Trans. Amer. Phila. Soc., vol. 15, p. 254, In part.
Arca umbonata Sheldon, 1916, Palæont. Amer., vol. 1, p. 8. pl. 1, figs. 12-17.
Arca umbonata Maury, 1917, Bull. Amer. Pal., vol. 5, p. 327, pl. 30, fig. 11.
Arca mubonata Maury, 1920, New York Academy of Science, Sci. Sur. of P. R., vol. 3, pt. 1, p. 6.

The *Arca umbonata* and the preceding *occidentalis* area common as recent shells along the entire northern coast of Panama and Costa Rica. The *A. umbonata* is recognized by its more convex and angular shell and finer sculpture of the middle of the shell disk. As a Gatun fossil we have but a single small shell from the East Grape Point Creek. Dr. Maury records the species from the Miocene of Santo Domingo and from Porto Rico.

Gatun Stage: Coll. 1, East Grape Point Creek.

Subgenus **BARBATIA** (Gray) Adams

Arca Mauryae, n. sp. Plate 22, figure 4, 7

Barbatia cf. *Bonaczyi* Maury, 1917, Bull. Amer. Pal., vol. 5, p. 329, pl. 30, fig. 15. Not of Gabb.

Shell small, thin, convex, subrhomboidal in form; umbos wide and full; with the beaks at the anterior 1-3 of the shell; a rounded posterior umbonal slope; the anterior extremity is broken in the type specimen but from the earlier growth lines is simply rounded in form; the posterior side is obliquely truncate and meets the dorsal margin in a well-marked angle; the exterior is sculptured like that of *Arca barbata*, with the riblets grouped in wide, regular bands which are defined by slightly deeper interspaces; the radial riblets are crossed and crudely granulated by concentric threads; the sculpture on the posterior submargins is much heavier and predominantly radial that of the anterior submargin is but slightly heavier than on the middle of the shell disk; interior of shell cavity deep, with a straight hinge-margin, the teeth arranged as in *barbata*; cardinal area rather high, longitudinally striated posterior of the beaks, plain in front.

Length 24? height 11.50, semidiameter 5.50 mm.

This species is closely related to the recent *Arca barbata* Linné. It differs from *barbata* in its proportional shorter shell, greater convexity, less anterior beak and higher cardinal area. It is equivalent to the Dominican shell figured by Dr. Maury as *Barbatia* cf. *Bonaczyi* Gabb. Gabb in his remarks following his his description of *Bonaczyi*, compares his shell with *barbata*, and states that in *Bonaczyi*, the beaks are more anterior and the posterior end more produced and sloping. This is the reverse of the conditions as seen in the present shell. Dall on the other hand, considers Gabb's shell as synonymous with *Arca umbonta* Lamarck.

Gatun Stage: Port Limon.

Section **CALLOARCA** Gray

Arca cf. candida Gmelin Plate 22. figures 5, 6

Arca candida Gmelin, 1792, Syst. Nat., p. 3311.

Barbatia (*Calloarca*) *candida* Dall, 1898, Trans. Wagner Free Inst., Sci., vol. 3, pt. 4, p. 626.

Arca cadida Shelton, 1916, Palaeont. Amer., No. 1, p. 16, pl. 3, figs. 11, 12.

We have several small valves of a *Calloarca* from the Miocene limestones of Port Limon, the largest of which has a length of 18 mm. They belong to the *Arca candida* group and may possibly represent the young of that species. They seem to differ in being more finely sculptured, especially about the middle of the shell disk. This sculpture consists of fine, beaded or granulated radial threads, which become coarser on the anterior and posterior submargins.

The *Arca candida* is recorded by Dall from the Bowden beds of Jamaica, the equivalent of the coral limestones of Limon. Dall also mentions from the same locality, the occurrence of a smaller and possible distinct species. The *Arca candida* is a common recent species of the West Indies and the Caribbean, and is abundant on the north coast of Panama and Costa Rica.

Length 18, height 11?, semidiameter 3.75 mm.

Gatun Stage: Port Limon.

Subgenus **SCAPHARCA** Gray

Arca dariensis Brown and Pilsbry Plate 22, figures 10-13

Arca oronlensis Dall, 1898, Trans. Wagner Free Inst. Sci., vol., 3, pt. 4, p. 658. Not of Gabb.

Arca dariensis Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. Phila., vol. 63, p. 362, pl. 22, fig. 10.

Arca gatunensis Toula, Dec. 1911, Jahrb. der K-K Geol. Reichsanstalt, vol. 61, p. 493, pl. 30, fig. 4.

The common Ark of the Canal Zone. The shell is elongate in form with about 30 ribs. The ribs of the left valve are usually granulated over the whole shell, while those of the right valve are narrow and smooth on the middle of the shell disk. The ribs are characteristically divided on the anterior and posterior ends of the shell.

Gabb has described an *Arca oronlensis* from the black shales of Oronli Creek in the Talamanca Valley (probably the Uscari shell). It is like *A. dariensis*, in form, but with more central beaks and umbones and simple ribs. We have not seen this species.

Gatun Stage: Gatun and Mt. Hope, C. Z.
Wvter Cay.

Arca actinophora Dall Plate 23, figs. 7, 8; Plate 25, fig. 3

Scapharca (*Scapharca*) *acitnophora* Dall, 1898, Trans. Wagner Free Inst. Sci., vol. 3, pt. 4 p. 647, pl. 33, fig. 26.

Scapharca (*Scapharca*) *actinophora* Sheldon, 1916, Paleont. Amer., vol. 1, p. 50, pl. 11, fig. 13.

A larger species than the *dariensis*, with broad, wide umbos. The ribs number 36 to 40, are narrow and separated by interspaces of a little more than their own width. These interspaces are generally finely ornamented by regular, even, concentric threads. The ribs are simple and on the left valve, usually strongly beaded or granulated throughout, becoming wider and smoother on the posterior portion, or with the granulations only on their edges, so that the ribs appear as if mesially depressed. The ribs of the right valve are less strongly beaded and may become quite smooth, especially on the center of the shell disk.

Its ventral margin is gently curved to the rounded and not pointed posterior extremity.

It is a common species at Mt. Hope in the Canal Zone, but it also occurs but less abundant in Western Panama and in Costa Rica.

Gatun Stage: Mt. Hope, C. Z.
Water Cay, Panama.
Zone 4, Red Cliff Creek, C. R.
Coll. 3, Hone Walk Creek, C. R.
Hill 1 Banana River, C. R.

Arca Henekeni Maury Plate 24, figs 13, 14

Arca consobrina Sowerby, 1849, Quart. Journ. Geol. Soc. London, vol. 6, p. 52, pl. 10, fig. 12. Not of d'Orbigny, 1844.

Arca consobrina Guppy, 1876, Quart. Journ. Geol. Soc. London, vol. 32, p. 531.

Arca consobrina Dall, 1888, Trans. Wagner Free Inst. Sci., vol. 3, pt. 4, p. 646.

Arca consobrina Sheldon, 1916, Paleont. Amer., No. 1, p. 49.

Arca Henekeni Maury, 1917, Bull. Amer. Pal., vol. 5, p. 331, pl. 29, fig. 2.

Arca (*Scapharca*) *sobrina* Pilsbry and Johnson, 1917, Proc, Acad. Nat. Sci. Phil., vol. 64, p. 186.

Our shells from Water Cay are similiar in form and general sculpture to the *A. Henekeni* Maury (*A. consobrina* Sowerby), from the Miocene of Santo Domingo, the only noticeable difference being the greater number of ribs on the Panama shell. The ribs of *Henekeni* from Water Cay average about 39 in number, and 35 to 36 on the Dominican shells. The ribs of the left valve are evenly beaded or granulated by concentric threads which pass across the interspaces as elevated threads. The ribs of the posterior-dorsal submargins are nearly smooth. They are more or less divided at the anterior extremity and very finely beaded.

Length 29, height 18.25, diameter 14.15 mm.
31, 18, semidiameter of right value 7.25 mm.

Gatun Stage: Water Cay.

Arca costaricensis, n. sp. Plate 25, figures 1, 2

Shell moderately large, elongate, convex, with the beaks situated at the anterior 1-3; ventral margin but gently curved to the attenuated and pointed posterior extremity; right valve with about 30 ribs, of which the most anterior and posterior ones are rather wide, the others narrow; interspaces on the center or the disk 3 times or more the width of the ribs; the ribs of the right valve are obscurely granulated on the anterior extremity, more or less smooth on the center but on the posterior extremity, they are double and peculiarly granulated along their sides;

this granulation begins on the sides and on the more anterior ribs, the center is smooth; this granulation is in the form of inverted V's; their acute apices lying along the center of the ribs; the ribs of the left valve are more or less granulated or beaded throughout and with the ribs on the posterior extremity, double and similiar to those of the right valve; hinge-line straight, with very numerous small, uninterrupted teeth; a rather wide cardinal area with 5 or 6 ligamental grooves; ventral margin internally fluted in harmony with the external ribs.

Length 52,	height 28,	diameter 34 mm.	
52,	32,	17 mm (right valve).	

The form of this shell with its gently curved ventral margin and attenuated posterior extremity is like the *Arca actinophora* Dall, but is longer and with fewer and heavier ribs. On the other hand, this species may be compared with *dariensis* Brown and Pilsbry, from which it differs most strikingly by its larger size, wider, higher and more central umbos and more pointed attenuated posterior extremity.

Gatun Stage: Hill 1a, Banana River.
Hill 2, Banana River.
Zone 7, Pumbri Creek.

Arca honensis, n. sp. Plate 22, figures 8, 9

Shell rectangular, elongote, moderately convex; beaks situated at about the anterior 1-4; right valve with about 26, narrow, smooth or irregularly granulated ribs, separated by interspaces of twice their own width; the left valve with the same number of ribs and similiar to those of the right valve; the ribs of both valves are simple and undivided and if granulated, most heavily on the anterior half of the left valve; interspaces smooth or with irregular, raised concentric threads; cardinal area long and rather wide and with 5 or 6 linear grooves; hinge-lines straight with very numerous, small, uninterrupted teeth; ventral margin fluted in harmony with the external ribs.

Length 39,	height 23.5,	semi-diameter 11 mm	(lest valve)
36.5	23	12	(left valve)
34	23	11	(right valve)

In general form, quite similiar to the *Arca dariensis* Brown and Pilsbry, but distinguished mainly by its simple, undivided ribs. It is also a more convex shell, with higher and more prominent umbos. It differs from Gabb's figure of *A. oronlensis* in its more anterior umbos.

It is a common species, occurring in zones in the Gatun sandstone of Hone Walk Creek of Eastern Costa Rica.

Gatun Stage: Hone Walk Creek.

Arca golfoyaquensis Maury, var. **medioamericana**, n. var.

Plate 23, figures 4-6

cf. *Arca golfoyaquensis* Maury, 1917, Amer. Pal., vol. 5, p. 332, pl. 28, fig. 5.

? *Arca* (*Andara*) *consobrina* Gabb, 1881, Journ. Acad. Nat. Sci. Phila., 2nd series, vol. 8, p. 378.

The *Arca golfoyaquensis* was described by Dr. Maury from the Gurabo and Cercado formation of Santo Domingo. It is closely related to the *Arca Henekeni* Maury, (the *Arca consobrina*) differing mainly in form.

The Costa Rican shells are very similiar to Dr. Maury's type specimens of *golfoyaquensis*, but differ in having 35 instead of 38 ribs, a higher shell, fuller umbos and sharper ribs on the posterior-dorsal area. The central ribs of the left valve are elegantly beaded with their interspaces evenly sculptured with raised concentric threads. On the right valve, the ribs are more smooth but their interspaces are similiarly sculptured to those of the left. The ribs of the posterior-dorsal angle of both valves become divided ventrally by 2 or 3 fine threads. The posterior extremity is straight, meeting the hinge-line at an angle of nearly 120 degrees.

Length 54, height 34, diameter 34 mm.

Gatun Stage: Hill 1, Banana River.
Coll. 5, Red Cliff Creek.
Rio Blanco.
Old Man Sam Creek, 1 mile south of beach.

Arca Veatchi, n. sp. Plate 23, figures 1-3

Shell large, moderately convex; in outline, the shell is nearly square with the height about equal to its length; the anterior side is widely rounded to the ventral margin, the posterior side nearly straight, nearly at right angles to the hinge-line; umbos wide, with the unbonal angle widely rounded and with the extreme tip of the beaks situated at the anterior 1-3 of the total length of the shell; right valve with about 45 ribs, of which the posterior 14 are on the posterior-dorsal slope; the ribs are rectangular in section with the interspaces on the center of the disk about 3-4 of the width of the ribs; the ribs are finely sculptured but less strongly on the right valve; on the center of the shell disk, the ribs are finely nodulated or granulated but on the posterior-dorsal slope and on the anterior extremity, the granulations of the ribs is gradually overshadowed by the introduction of 4 or 5 fine, threads on the top of each rib the interspaces on the center of the disk of the left valve are finely sculptured with even, raised concentric threads; the left valve is slightly larger and overlaps to a small extent the right; hinge-line straight with numerous small teeth, larger and higher at the extremities; cardinal area that of typical *Scapharca*, and grooved with 3 lines; interior of the shell deep, with the posterior adductor scar about twice the size of the anterior; basal margin fluted in harmony with the external sculpture.

Length 51, height 51, diameter 41.5 mm.

This is a rather large, *Cardium*-like *Arca* of nearly square outlines and numerous finely sculptured ribs. Its form is also suggestive of *Argina*, but its cardinal area is that of a true *Scapharca*. The type specimen, a finely preserved individual with both valves comes from the Gatun of Water Cay. It is quite unlike any other known American species.

It is named for Dr. A. C. Veatch, Director of the Exploration Department of the Sinclair Consolidated Oil Corporation.

Gatun Stage: Water Cay.
Mt. Hope, C. Z.

Arca auriculata Lamarck Plate 22, figure 3

Arca auriculata Lamarck, 1819, n. s. Vert., vol. 6, p. 43.

Arca (*Scapharca*) *auriculata* Dall, 1898, Trans. Wagner Free Inst., Sci., vol. 3, pt. 4, p. 649.

Arca auriculata, Sheldon, 1916, Paleont, Amer., vol. 1, p. 50, pl. 11. fig. 19,

Scapharca auriculata Maury, 1917, Bull. Amer. Pal., vol. 5, p. 339, pl. 28, fig. 3.

A common, recent species of the West Indies. Its hingeline is generally produced or auriculated at its posterior extremity.

It occurs in the Miocene of Jamaica and Santo Domingo. Dall also records it from near Limon.

The Costa Rican specimens in our collection are all small but otherwise typical.

Gatun Stage: Coll. 3, Hone Walk Creek.
Old Man Sam Creek, 1 mile south of the beach.

Section **CUNEARCA** Dall

Arca cacica, n. sp. Plate 24, figure 1

Shell of moderate size, strongly convex and with high, inflated umbos; beaks and umbos about the middle of the shell; the greatest convexity of the shell lying about the anterior 1-3, and with a narrow but deep, radial depressed zone extending from the beaks to the ventral margin, just anterior to the umbonal angle; the anterior end is slightly rounded, the posterior submargins strongly depressed or flattened with a straight posterior margin; the left valve with 30 smooth and strongly nodulous radial ribs of which 9 are situated on the posterior submargin; the ribs of the posterior submargin are low, wide and nearly smooth; on the rest of the shell, the ribs are nodulose, very regularly in the middle of the valves more distantly on the anterior ribs; the interspaces between the ribs are narrow on the middle of the valves, become wider anteriorly and on the extreme anterior extremity equal the ribs in width; the cardinal area is high, as nearly ½ of the length.

Length 39, height 33, diameter of the left valve 15 mm.

The above description is based on a single left valve from the Upper Gatun beds near Cahuita. Distantly related to the *Arca incongrua* Say and its southern form *brasiliana* Lamarck, the fossil species differs in its higher and more convex shell, and in its high cardinal area. In this latter feature, this species is like the recent West Coast *Arca labiata* Sowerby, but has a greater number of ribs and different form.

Gatun Stage: Across the divide from Comadre Creek.

Groups of *Arca Pittieri* Dall

This is a group of small and medium-sized Arks, containing 3 species, whose general appearance is that of the recent *Arca Chemnitzi* Phil. The Costa Rican shells are usually abundant wherever they occur in the Gatun formation. Their relations and differences may be summarized as follows:

A. Both valves more or less similiarly sculptured, that is the ribs of the posterior half of the right valve, at least obsoletely beaded.

B. Ribs 25 to 28; umbos high and full; posterior-dorsal slope, angular; posterior extremity somewhat produced, giving an elongate outline to the shell.

Area Pittieri Dall

AA. Valves not similiarly sculptured; posterior half of the right valve with narrow ribs, separated by wide interspaces.

B. The intervals between the ribs on the posterior half of the right valve with small (sometimes faint) interstitial threads. Ribs about 29.

Arca Lloydi, n. sp.

BB. The intervals between the ribs on the posterior half of the right valve smooth; ribs 25, shell usually larger.

Arca Hindsi, n. sp.

Arca Pittieri Dall Plate 24, figures 2-6

Arca (*Scapharca*) *Pittieri* Dall 1912, Smith. Misc. Coll., vol. 59, No. 2, p. 9.

This is a common species in the Gatun beds of the Banana River. The ribs of the 2 valves are similarly sculptured but somewhat less strongly on the right. The umbos are high. The posterior extremity is pointed and produced so that the outline of the shell is more elongate than in the following species:

Length 25, height 25, diameter 26 mm.
29 28 semi-diameter 14.5 mm.

Gatun Stage: Hill 1a, Banana River, 3.
Zone E, Saury Creek.
Rio Betey.
Coll. 7, Pumbri Creek.

Arca Lloydi, n. sp, Plate 24, figures 10-12

Shell small, cordiform, covex, subrectangular in outline but with the left valve somewhat more pointed at its posterior-ventral extremity; anterior side well rounded; posterior side straight and meeting the basal margin at an angle of about 75 degrees; umbonal angle rounded; the left valve has 29 ribs of which 9 are found on the posterior- dorsal slope; the ribs of the left valve are strongly beaded or granulated, and separated by interspaces of about their own width; on the right valve, the first 10 anterior ribs are strongly beaded; the next set as far as the umbonal angle are smooth, beyond which on the posterior-dorsal slope the ribs again become beaded as they approach the dorsal margin; the interspaces on the right valve are wide, and on the shell disk anterior to the umbonal angle they carry a fine, but often faint interstitial thread; the intervals are otherwise smooth or finely etched with concentric lines; hinge-lines straight with numerous small, vertical teeth and a wide, smooth cardinal area.

Length 18, height 18, semi-diameter 9.5 mm.

A smaller species than the following (*Hindsi*) and easily distinguished by the interstitial thread of its right valve. It is much less common than the other two species.

Named for Dr. E. R. Lloyd, formerly of the United States Geological Survey, and who was a member of the first Exploration Party of the Sinclair Oil Company in Panama and Costa Rica.

Gatun Stage: Hill 3, Banana River.
Zone 5, Red Cliff Creek.
Coll. 7, Pumbri Creek.

Arca Hindsi, n. sp. Plate 24, figures 7-9

Shell small or of medium size, cordiform and similiar in outline to the preceding species but larger; umbos high and wide, and but slightly anterior to the middle; the left valve has about 26 strongly nodulated ribs, separated by interspaces of slightly greater width; the first 9 or 10 ribs of the right valve are nodulated, followed by smooth ones to the umbonal angle, beyond which the remaining 7 become nodulated as they approach the dorsal margin; interspaces wider than the ribs, smooth and without any interstitial thread; hinge-line straight with numerous, small vertical teeth and a wide, smooth cardinal area; on some shells the ligamental area may carry one or two, small diamond-shaped grooves.

Length 24, height 25, semi-diameter 14 mm.

A much larger species than the *Lloydi* and without any interstitial thread in the interspaces of its right valve. It is named for Dr. Henry Hinds, formerly of the United States Geological Survey and the Exploration Department of the Sinclair Consolidated Oil Corporation.

Gatun Stage: Hill No. 3, Banana River.
Zone E, Saury Creek.
Coll. 1, East Grape Point Creek.
Coll. 3, East Grape Point Creek.
Rio Betey.

Subgenus **NOETIA**, Gray

Arca MacDonaldi Dall Plate 25, figures 4-7

Arca (*Noetia*) *MacDonaldi* Dall, 1912, Smith, Misc. Coll., vol. 59, No. 2, p. 9.

This large *Noëtia*, is very common and characteristic of the Gatun formation in many parts of Northern Costa Rica, and large specimens may reach a length and height of 55 mm or more. It was originally described by Dall from specimens collected by Pittier and MacDonald from the Gatun beds of the Banana River, where it is associated with *Arca Pittieri* and is very abundant.

Two forms or varieties may be recognized. In typical *MacDonaldi*, the shell is high, trigonal, with *elevated*, *narrow umbos* and a *producted anterior extremity*. The beaks are separated from the hinge-line by a *wide ligamental area*. This is the common form along the Banana River. Frequently associated with typical *MacDonaldi* are shells with a more *rectangular outline*, *lower* but *wide* umbos. The beaks are close to the hinge line so that the *ligmental area is narrow*. These two types have a very different appearance but seem to be connected by transitional forms. To the last variety, I propose the name of *subreversa*.

Among recent shells, the *Arca MacDonaldi* finds its closest relation with the common *Arca reversa* Sowerby of the Pacific coast of Central America.

Gatun Stage: Hill 1, 1a, Banana River, typical and var. suberversa
Coll. 7, Pumbric Creek (typical)
Coll. 6, Red Cliff Creek (typical)
Betey (subreversa)
Zone G, Saury (subreversa)

Genus **PTERIA,** Scopoli

Pteria inornata Gabb Plate 28, figure 9

Avicula inornata Gabb, 1873, Trans. Amer. Phil. Soc., vol., 15, p. 253.

Pteria inornata Dall, 1898, Trans. Wagner Free Inst. Sci., vol. 3, pt. 4, p. 669.

Pteria inornata Maury, 1817, Bull. Amer. Pal., vol. 5, p. 345, pl. 26, fig. 14.

This species is locally common in Costa Rica, but generally difficult to collect because of its thin and fragile shell. Its valves are as high as long, strongly convex and smooth. The anterior ear is of medium size, the posterior much larger and produced.

It was described as a Miocene fossil from Santo Domingo, but has also been collected at Bowden.

Uscari formation. Old Harbor.
Gatun Stage: Zone 3; Red Cliff Creek.

Genus **OSTREA,** Linnæus

Ostrea megodon Hanley Plate 18, figure 1

Ostrea megodon Hanley, 1845, Proc. Zool. Soc. London, p. 106.

cf. *Ostrea cerrosensis* Gabb, 1869, Geol. Surv. Calif., vol. 2, p. 35, pl. 11, fig. 61.

Ostrea megodon Dall, 1897, Trans. Wagner Free Inst., vol. 3, pt. 4, p. 685.

Ostrea megodon Maury, 1917, Bull. Amer. Pal., vol. 5, p. 347, pl. 34, fig. 3.

This is a medium sized and sickle-shaped oyster with 4 or 5, large, tooth-like folds on the anterior and ventral margins. The beak and ligamental area are directed upwards and sometimes strongly to the posterior side. Its external surface, although strongly and deeply folded, is plain and nearly smooth.

The *Ostrea megodon* is a recent species along the west or Pacific coast of Central America. It occurs also as a Miocene fossil in Santo Domingo and in the Bowden beds of Jamaica.

Gatun Stage: Water Cay.
Coll. 4a, East Grape Point Creek.
Hill 1a, Banana River.

Ostrea costaricensis, n. sp. Plate 21, figure 2

Ostrea sculpturata Bose, 1906, Boll. de Inst. Geol. de Mexico, numero 22, p. 76, pl. 9, fig. 4. Not of Conrad, 1840.

Shell of medium size, subcircular in form but somewhat oblique; the shell is somewhat flexed or slightly saddle-shaped, the concave side of which corresponds to the left valve; both valves are strongly sculptured, the right with narrow, rib-like costæ and wider interspaces, the left valve with the reverse of the sculpture of the right; the ribs are more or less nodose or knobbed and are crossed by irregular concentric lines, which in some cases may become raised or lamellar-like; the hinge margin is irregularly crenulated.

Height 50, length 47, diameter 19 mm.

The type is a specimen from the Gatun of the Rio Blanco with both valve tightly closed so that the interior cannot be seen. What appears to be the same species, is represented by several sessile and free valves from East Grape Point Creek, and which are associated with *O. megodon*.

It differs from the *Ostrea gatunensis - haitensis* group by its smaller size; less heavy shell and in that the ribs of the valves are narrow and costæ-like and not long, strong plicæ. Bose has recorded and figured this species as *Ostrea sculpturata* Conrad from the Miocene (as Pliocene) of the State of Oaxaca, Mexico. It is very distinct from the East Coast, Chesapeake Miocene *Ostrea sculpturata* both by its form and sculpture.

Gatun Stage: Rio Blanco.

Coll. 4a, East Grape Point Creek.

The collection also contains fragments or much decayed specimens of two or more large oysters, one of which is probably the *gatunensis* Brown and Pilsbry of the Canal Zone, and a large, heavy *sellæformis*-like species, possibly the *Gilbertharrisi* Maury of the Dominican Miocene. The specimens are however too fragmentary for positive determination.

Genus **PECTEN**, Muller

Pecten gatunensis Toula Plate 16, figures 3, 4

Pecten (*Flabellipectcn*) *gatunensis* Toula, 1908, Jahrb. der K-K Geol. Reichsanstalt Wien, vol. 58, p. 711, pl. 29, fig. 2.

Pecten gatunensis Brown and Pilsbry, 1911, Proe. Acad, Nat. Sci. Phila., vol. 63, p. 365.

Shell rather large, subcircular; the left valve is nearly flat or slightly vaulted transversely across the middle of the shell; the right valve is moderately convex; the ears are small and nearly equal,those of the right valve slightly flaring at the sides; the right valve has 23 or 24 fairly strong ribs separated by interspaces a little more than ½ of their width; in large right valves, some of the central ribs become dichotomously or trichotomously divided but this feature is not always developed to the same extent on all shells; the left valve has 18 or 19 ribs which fade out on the wide dorsal submargins; the ribs of the left valve are narrow with the interspaces nearly twice as wide; the surface is covered with fine, even, raised concentric threads best preserved on the left valves; interior fluted.

Length 62, height 60 ? diameter 12.5 mm.
62 60 ? 4 mm (left valve)

We have redescribed this species as Toula had but a specimen of the right valve. It is a true *Pecten*, distantly related to the *Pecten hemicyclicus* Ravenel from the Chesapeake Miocene of Florida and the Carolinas, but is smaller and less broad. In both species, the ribs on the right valves of large specimens become divided in the same manner.

Gatun Stage: Gatun, C. Z.
Water Cay,

Pecten MacDonaldi, n. sp. Plate 16, figures 1, 2

Shell large, subcircular; ears of medium size and equal; left valve is slightly convex due to the middle of the shell being transversely humped or vaulted and a depressed zone follows on the inner slope of each of the raised dorsal submargins; the right valve is slightly but evenly convex; sculpture of the right valve consists of about 26, low ribs which widen out as they approach the ventral margins; their interspaces are at first nearly as wide as the ribs themselves but become only ½ or ⅓ as wide ventrally; the left valve has 21 or 22 narrow ribs and wider interspaces; on the dorsal submargins, the ribs are small and fade away; surface with fine, even, raised lines best seen on the left valve.

Length 106, height 97, semi-diameter 12 mm.
83 80 mm.

The fragmentary Toro limestone at Gatun and Toro Point contains very few good fossils, although the rock itself is composed almost entirely of broken and ground fragments of shells and barnacles. Dall has described an *Epitonium toroensis* from the Toro Point limestone where it is fairly common. The *Pecten MacDonaldi* is found in the Toro limestone which caps the hills just west of the locks at Gatun.

This species has much the same contour as the recent *Pecten maximus* Linné, from Europe. It is a larger species than the *Pecten gatunensis* Toula.

Toro Limestone. Gatun, west of the locks.

Pecten coralliphila, n. sp, Plate 17, figures 5, 6

Shell small, very thin and generally translucent; broader than high; right valve moderately convex, the left concave with raised submargins; ears small and subequal; sculpture of the right valve of about 23 low, flat ribs, with flat interspaces a little more than ½ the width of the ribs; some of the ribs may become divided medially; the ribs of the left valve, about 20 in number, are narrow, usually somewhat irregularly spaced so that their interspaces are of variable width and new ribs may occasionally appear in the wider interspaces near the ventral margin; surface in addition finely sculptured with even, raised concentric threads; interior of the shell fluted well into the cavity of the shell, in harmony with the external ribs.

Length 34, height 29, semi-diameter 4 mm (right valve)

This *Pecten* is fairly common in the coralline phases of the Miocene and its associated marls and sands. It is extremely thin and fragile in texture. Its sculpture resembles that of *Pecten gatunensis* Toula but is much more irregular. The interspaces of the left valve are of very variable width.

Gatun Stage: Port Limon.

Subgenus **CHLAMYS**, Bolton

Section **PLAGIOCTENIUM** Dall

Pecten levicostatus Toula Plate 16, figures 5-7

Pecten tevicostatus Toula, 1908, Jahrb. der K-K Geol. Reichsanstalt, Wien, vol. 58, p. 713, pl. 26, figs. 4, 5, 6.

Pecten (*Chlamys*) *santarosanus* Bose, 1906, Boll. de Inst. Geol. de Mexico, numero 22, p. 73, pl. 6, figs. 3, 4. ? *Pecten* (*Chlamys*) *santarosanus* Bose, *op. cit.* p. 23, pl. 1, figs. 1 and 4, 2 and 5.

A scallop of the general type of *Pecten ventricosus* Sowerby; both valves equally and strongly convex; ribs about 21, which are square or rectangular in section on the umbos and with deep interspaces; the ribs generally flatten or become more rounded in large shell near the ventral margins; the interspaces are covered with fine, raised, concentric lines, best seen on the umbos or on young shells; they become more crowded towards the ventral margins and may pass over the tops of the ribs as well; the dorsal and posterior submargins are strongly flattened and sculptureless; the anterior ear is a little larger, projects forward and carries, in the right valve, a byssal notch; it is sculptured with several radial riblets; the posterior ear has its upper half nearly smooth or but faintly sculptured, but its lower half carries a band of 5 or 6 strong, radial cords.

Height 29,	breadth 34,	thickness 10.50 mm	(right valve)
34	38	23	(both valves)
39	43	14	(left valve)

This is the common *Pecten* in Costa Rica and frequently forms zones in the lower part of the Gatun formation. All our specimens have 21 ribs, which vary from strongly rectangular in section with deep interspaces to more flattened and rounded on the larger individuals.

Bose has described as *Pecten santarosanus*, a small scallop shell from the Miocene of the State of Oaxaca, Mexico. The ribs number 23 to 25. Later in the same volume, he figured a larger *Pecten* from the Miocene of La Barranca de Santa Marie Tatella, as *Pecten santarosanus*. This shell has but 21 ribs and is equivalent to Toula's *levicostata*. If this larger specimen of Bose's is equivalent to his typical *santarosanus*, this name must of course take priority over Toula's *levicostatus*. As Bose's typical *santarosanus* has 23 to 25 ribs, while in *levicostatus* the ribs appear to be constantly but 21 in number, they probably represent two different species.

In the Dominican Miocene *levicostatus* is represented by the *Pecten excentricus* Gabb, which appears to differ constantly by its lower and more rounded ribs and smaller ears. The recent Pacific *Pecten ventricosus* Sowerby is closely related and probably the direct descendent of *levicostatus*. In that species, the ribs are low and rounded as in *excentricus* and as occasionally seen in large examples of *levicostatus*. The sculpture of the posterior ear is uniform. In the Chasapeake Miocene fauna the *Pecten eboreus* Conrad, variety *comparilis* Tuomey and Holmes is distantly related, but is larger, less convex and generally with more numerous ribs.

Gatun Stage: Gatun, C. Z. Quitana Creek.
Water Cay.
Hone Creek.
Banana River.
Estrella River.

Pecten costaricensis, n. sp. Plate 18, figures 8-11

Shell small, inequivalve, oblique; the right valve is moderately convex, the left but slightly; right valve with 17 flat-topped ribs, square in section and with deep U-shaped interspaces of a width equal to the ribs; these interspaces are sculptured with fine, concentric, raised lines which are quite far apart on the umbos, but become crowded ventrally or disappear entirely; the left valve has 17 or 18 ribs which are lower and more rounded in section; the fine concentric lines on the left valve are confined to the umbos, the interspaces over the greater part of the shell being smooth; the anterior and posterior dorsal slopes are flattened and smooth, but sculptured below in each valve by strong radial threads on the lower side of the ears; ears subequal; the right valve with a deep, byssal notch in its anterior ear; the left valve has the lower half of each ear with 3 strong radial threads, while on the upper half, the radial threads are largely obsolete; valves internally grooved in harmony with the external ribbing to about the center of the shell.

Height 26.50,	breadth 28,	thickness 7.50 mm (right valve)
24	24	4.00 mm (left valve)
27	28	5.50 mm (left valve)

Differs from the *Pecten levicostatus* Toula, by its unequal valves, less convexity and fewer ribs. It is somewhat like the *Pecten inæqualis* Sowerby, from which it is distinguished by its more flattened left valve and lower, smaller ribs of its right. In *inæqualis*, the fine, lamellose, concentric lines cover the entire interspaces between the ribs on both valves, while in the present species the interspaces of the left valve are largely smooth with the concentric lines confined to the extreme umbonal area.

Gatun Stage: Coll. 4, Red Cliff Creek.
1 mile south of the beach, along Old Man Sam Creek.
Coll. 4, East Grape Point Creek.
Rio Blanco.

Section **AEQUIPECTEN,** Fischer

Pecten (Aequipecten) preglyptus, n. sp. Plate 17, figures 2, 7

Shell of moderate size, subcircular in form and convex; ears of usual size, subequal and with a straight hinge-line; sculpture of about 16 or 17 wide, little elevated ribs and narrower, scarcely distinguishable interspaces; the surface is otherwise smooth or with fine, concentric lines; interior of the shell with 29 or 30 *Amusium*-like internal liræ which are evenly spaced and not in pairs; these liræ are very faint in the middle of the shell cavity but strong distally.

Length 50, height 49, semi-diameter 6.5 mm.

An *Amusium*-like species found in the lower sandstones and conglomerates of the Gatun formation in upper Cocles Creek. It is closely related to the recent deep-water *Pecten glyptus* Verrill from the cost of Hatteras and Marthas Vineyard (see Dall Proc. U. S. Nat. Mus., vol. 12, p. 248, pl. 8, figs. 2, 3), both species having about the same number of low, wide ribs and internal liræ. The fossil shell seem to have been nearly circular while *glyptus* is decidely oblique in outline.

Gatun Stage: Upper Cocles Creek.

Subgenus **PSEUDAMUSIUM**, H. and A. Adams

Section **PSEUDAMUSIUM**, s. s.

Pecten almirantensis, n. sp. Plate 18, figure 16

Shell small, thin, compressed or but slightly convex; the posterior and anterior dorsal slopes are straight, meeting the beaks at an acute angle; the right valve is finely sculptured with close, regular, concentric lamellæ and wider interspaces; the posterior and anterior sides show a few, irregular, radial threads which cross the concentric lamellæ; the ears are unfortunately broken; the interior of the shell cavity is filled with a thin deposit of callus; ventral margin plain; hinge line minutely grooved with vertical lines.

Length 4.75, height 4.75, diameter of right valve 60 mm.

This small, elegant species is represented solely by an imperfect right valve and represent the first true *Pseudamusium* to be discovered in the Miocene beds of Panama. Its sculpure is like the recent deep water *Pseudamusium strigillatum* Dall from the West Indies, but differs in having its anterior and posterior dorsal submargins meeting at the beaks at a much more acute angle.

Gatun Stage: Bocas del Toro.

Section **CYCLOPECTEN**, Verrill

Pecten oligolepis Brown and Pilsbry

Pecten aff. *subhyalinus* Smith, Toula, 1911, Jahrb. der K-K Geol. Reichsanstalt, Wien, vol. 61, p. 492, pl. 31, figs. 1a, b, c.

Pecten (*Cyclopecten*) *oligolepis* Brown and Pilsbry, 1912, Proc. Acad. Nat. Sci. Phila., vol. 64, p. 512, text-figure 5.

A very small species with broad, nearly smooth valves and large ears. The right anterior ear has a deep byssal notch and its surface is sculptured with fine, raised, concentric, lamellose lines. The ears of the left valve are similiarly sculptured but finer. The surface of the valves appear nearly smooth but in well-preserved specimens very faint concentric lines and fine radial striæ may be seen. The left valve is more coarsely sculptured. The hinge is finely grooved with vertical lines. The measurements given by Pilsbry for his Gatun specimen, length 2.8, height 2.7, diameter of right valve .8 mm, are the usual dimensions for the Costa Rican specimens.

Gatun Stage: Gatun, C. Z.
Coll. 4, East Grape Point Creek.
Middle Creek.

Pecten aotus, n. sp. Plate 18, figures 17, 18

Shell small, thin, depressed or but slightly convex and *Amusium*-like; both valves except on magnification appearing smooth; ears of the left valve large and subequal; the anterior ear of the right valve about twice that of the posterior and carrying a deep, byssal notch; the surface of the left valve on magnification is seen to be sculptured with fine, radial lines which often occur in irregular streaks or blotches, imparting a peculiar appearance to the shell; the right valve is perfectly smooth and featureless, except for a band of rough scales on its anterior ear above the byssal notch; interior of shell cavity shallow, a simple ventral margin and the hinge-line vertically grooved with fine lines.

Length 4.5, height 4.5, diameter .75 mm. left valve.

Differs from *Pecten oligolepis* Brown and Pilsbry in its larger size, thinner and more *Amusium*-like shell, and strongly sculptured left valve. This sculpture consists of fine lines or *camptonectes* striations, which may be uniformly distributed but more usually occur in irregular streaks or blotches, imparting a distinctive appearance to the surface. This sculpture is seen only on a slight magnification, the shell otherwise appearing smooth and featureless. It is quite common in the coralline limestones of Port Limon.

Gatun Stage: Port Limon.
Coll. 5, Red Cliff Creek

Genus **AMUSIUM**, Bolton

Amusium luna Brown and Pilsbry Plate 17, figure 1

Amusium Mortoni Bose, 1906, Boll. de Inst. Geol. de Mexico, Numero 22, p. 24, pl. 1, figs. 3, 6, 7, 9. Not *Amusium Mortoni* Ravenal, 1844,

Amusium Mortoni Bose, *op. cit.* p. 74, pl. 8, figs. 1, 2; pl. 3, fig. 3.

Pecten (*Amusium*) cf. *Mortoni* Toula, 1908, Jahrb. der K-K Geol. Reichsanstalt, Wien, vol. 58, p. 714, pl. 26, figs. 8, 9.

Pecten (*Amusium*) *luna* Brown and Pilsbry, 1912, Proc. Acad. Nat. Sci. Phila., vol. 64, p. 514, pl. 23. fig. 1.

This is the common Gatun *Amusium* in Panama and Costa Rica. Its valves are nearly equal and but slightly convex; ears equal and small, and defined from the rest of the shell by a sharp ledge; the umbos, as well as the rest of the shell disk are smooth, except for the faint lines of growth; the internal ribs are in pairs, numbering about 23 and spaced at intervals nearly twice the width of the pairs of ribs themselves.

Bose and Toula both referred this species to the Upper Chesapeake Miocene and recent *Amusium Mortoni* Ravenel, from which it is very distinct. *Amusium Mortoni* is not only much larger (height 170 mm), but is porportionately much broader, and with larger ears which are defined simply by a line from the rest of the shell.

The Dominican *A. papyraceum* Gabb has larger ears, the internal ribs are more crowded and the left valve is generally strongly flexed along the anterior and posterior submargins. *Amusium Toulæ* Brown and Pilsbry, is found in the Gatun of the Canal Zone. Its surface is marked with dark-colored rays and is said to contain no internal ribs.

Gatun Stage: Gatun, C. Z.
Hotel Creek.
Zone 6, Old Man Sam Creek.
Coll. 4, East Grape Point Creek.

Amusium bocasensis, n. sp. Plate 17, figures 3, 4

Shell rather small, thin and subcircular in outline; moderately convex; ears proportionately larger than in *A. luna*, and with their dorsal margins slightly inclined upwards from the beaks to their outer edges; the surface is smooth and polished, finely covered with concentric growth-lines and faintly showing the position of the internal liræ; interior of shell with about 34 liræ, which are usually nearly evenly spaced and not in pairs; the internal liræ commence well in the interior of the shell, but are strongest distally.

Height 40, breadth 43.
35 38, thickness 6 mm. (right valve)

A much smaller and more delicate species than the *Amusium luna* Brown and Pilsbry. The internal liræ are more or less equally spaced and not in pairs. It differs from *Amusium Lyonii* Gabb from the lower Miocene of Sapota, Costa Rica by its much smaller ears.

Gatun Stage: Bocas del Toro.

Genus **SPONDYLUS**, Linnæus

Spondylus chiriquiensis, n. sp. Plate 20, figures 1, 2, 5, 6

Shell large, ponderous, equivalve and strongly convex; both valves of the same convexity, but with the beak of the right, high and projecting above the strongly incurved beak of the left; in large shells both valves are provided with a cardinal area, that of the right being both high and wide and for the greater part straight but the beak curving over it to a small extent at its upper end; the cardinal area of the left vale is much smaller, narrow and appears only with maturity and is more or less hidden by the strongly incurved beak; the sculpture consists of strong radial cords and small ribs divisible into 3 sets; a primary set of 7, which in perfect specimens and in the young carry large, strong spines; a secondary thread in each of the wide interspaces and when perfect bearing smaller spines, and tertiary threads of a variable number between the secondaries and primaries; the whole surface is in addition, finely, longitudinally starited with minute, scale-bearing threads; young shells have a small foliaceous area on the umbo of the sessile or right valve and strong spines on both valves.

Height 151, length 120, diameter 115 mm.

A large, ponderous species with nearly equal and strongly convex valves which show no distortion due to attachment Young shells associated with the type have a small, somewhat foliaceous attachment area on the right valve, and each valve bears large, strong spines on its primary set of radial cords and finer spines on its secondary and even on some of the tertiary threads.

Of described species, the *chiriquiensis* seems nearest related to the *bostrychites* Guppy from the Miocene of Santo Domingo and Jamaica but differs by its much larger size, proportionately more convex whorls and by its cardinal area which is more upright and with a more incurved beak at its upper end. The sculpture of *chiriquiensis* is more spiny, the spines being borne by the primary radials and to a less degree by the secondaries, and even by the tertiaries. In *bostrychites* only the primaries bear spines, the others appearing as large, nearly smooth, intermediate threads and cords. We have specimens of a large, closely allied *Spondylus* from the Chesapeake Miocene of Florida, differing mainly in its cardinal area and in details of sculpture.

Gatun Stage: Water Cay.

Spondylus gumanomocon Brown and Pilsbry Plate 21 figure 1

Spondylus americanus Gabb, 1873, Trans. Amer. Phil. Soc., vol. 15, p. 257. Not of Lamarck.

Spondylns gumanomocon Brown and Pilsbry, 1912, Proc. Acad. Nat. Sci. Phila., vol. 14, p. 514, footnote.

Spondylus gumanomocon Maury, 1917, Bull. Amer. Pal., vol. 5, p. 355.

This is a species with very unequal valves, that of the left or upper, being small, pectiniform and lacking in a cardinal area, while the right or lower valve is strongly convex, with a high produced beak and a high cardinal area. The sculpture of the two valves is similiar, except that the umbo of the right is strongly foliaceous. It occurs in the Miocene of Santo Domingo, where it was referred to the recent *S. americanus* by Gabb.

Gatun Stage: Coll. 2, Hone Walk Creek.
Port Limon.

Genus **PLICATULA**, Lamarck

Plicatula marginata Say Plate 28, figures 6, 7

Plicatula marginata Say, 1824, Journ. Acad. Nat. Sci. Phila., vol. 4, pp. 136-137, pl. 9, fig. 4.

Plicatula marginata Dall, 1898, Trans. Wagner Free Inst. Sci., vol. 3, pt. 4, p. 764.

The Panama and Costa Rican examples are not typical but they approach more closely the *Plicatula marginata* Say than they do the *densata* which Dall has recorded from the Bowden beds of Jamica.

The shells vary from subcircular to elongate and in some cases carry the dark, marginal band so frequently seen in typical *marginata*. The ribs number five to seven; the shells with more rounded form and more numerous ribs suggest the *densata*, but the ribs are higher and more foliaceous, and can be exactly duplicated by scores of true *marginata* in the Cornell collection. The above determination must however be considered as purely provisional at the present time.

The typical *P. densata* was described by Conrad from the lower Chesapeake Miocene of New Jersey, but it also occurs in the synchronous Calvert formation of Maryland. It is also found as a lower Miocene fossil in Florida and Dall recorded it from the Bowden beds of Jamaica and from the Oligocene of Guallava, Costa Rica. The *P. marginata* Conrad is an Upper Cheapeake Miocene and Pliocene fossil of the eastern United States.

Gatun Stage: Water Cay,
Old Man SamCreek, 1 mile south of the beach.

Genus **LIMAEA**, Born

Limaea solida Dall Plate 28, figure 10

Limæa solida Dall, 1898, Trans, Wagner Free Inst. Sci., vol. 3, pt. 4, p. 769, pl. 35, figs. 4, 5.

A small, solid shell, externally sculptured like a small *Glycymeris*. It has 12 rounded ribs and a coarsely crenulated basal margin. Our single specimen from Costa Rica is a little smaller than Dall's specimens from Bowden.

Gatun Stage: Coll. 4, Red Cliff Creek.

Genus **ANOMIA**, (Linné) Muller

Anomia simplex d'Orbigny Plate 21, figure 6

Anomia ephippium Conrad, 1845, Fossils of the Medial Tertiary, p. 75, pl. 43, fig. 4. Not of Linné.

Anomia simplex d'Orbigny, 1845, Hist. Pol. y Nat. Isla de Cuba, p. 367.

Anomia ephippium Gabb, 1873, Trans. Amer. Phil. Soc., vol. 15, p. 257.

Anomia simplex Dall, 1898, Trans. Wagner Free Inst., Sci., vol. 3, pt. 4, p. 784.

Anomia simplex Bose, 1906, Boll. de Inst. Geol. de Mexico, numero 22, p. 25, pl. 2, figs. 18-23.

Anomia simplex Maury, 1917, Bull. Amer. Pal., vol. 5, p. 355, pl. 26, fig. 15.

The *Anomia simplex* is both common and characteristic in the Gatun of Costa Rica as well as in certain parts of the Province of Colton, Panama, near the Canal Zone. It frequently gives rise to important zones in the lower part of the Gatun formation, where it occurs in large numbers associated with *Pecten levicostatus* Toula.

The specimens are generally large, thin-shelled, smooth and irregular in form, due to the object on which they were attached. They average for the upper valves about 35 mm in height.

Anomia simplex appears as a Miocene fossil in the eastern United States for the first time in the St. Mary's formation of Maryland in the upper part of the Lower Chesapeake. It occurs throughout the Upper Chesapeake Miocene and Pliocene and passes into the recent fauna. Locally as a fossil it may become very abundant, as at the base of the Pliocene overlying Upper Chesapeake Miocene along the shores of Lake Waccamaw, North Carolina. It occurs rarely as a Miocene fossil in Santo Domingo, where it has been recorded by Gabb and Maury. In Mexico, it occurs in the Miocene of Santa Rosa, Vera Cruz as figured by Bose.

Gatun Stage: Several localities, Prov. of Colon, Panama.
Middle Creek. Comadre Creek.
Hone and Hotel Creeks.
Hill No. 2, Banana River, Soury Creek, etc.

Genus **PLACUNANOMIA**, Broderip

Placunanomia lithobleta Dall Plate 21, figures 3, 4, 5

Placunanomia lithobleta Dall, 1898, Trans. Wagner Free Inst. Sci., vol. 3, pt. 4, p. 778.

Placunanomia lithobleta Maury, 1917, Bull. Amer. Pal., vol. 5, p. 356, pl. 34, figs. 1, 2.

The Costa Rican specimens are frequently widely plicate, nearly as much as in the Duplin Miocene *P. plicata* Tuomey and Holmes, but the surface is marked with fine, wavy, radial threads so that even very small fragments of this species are very easily recognized. It occurs in the Miocene of Jamaica, its type locality, and in the Miocene of Santo Domingo.

Gatun Stage: Hill 3, Banana River.

ORDER ANOMALODESMACEA

Genus **THRACIA,** Blainville

Subgenus **CYATHODONTA**, Conrad

Thracia Tristani, n. sp. Plate 20, fig. 3

Shell thin, subquadrate, the left valve slightly convex; the beaks situated at the posterior 1-3 of the shell, are low and inconspicuous; anterior end, wide and broadly rounded, the posterior contracted, depressed and truncated at its extremity; the surface is sculptured with regular wave-like folds, which on the middle of the shell are concentric, but are oblique on the anterior portion; they are lacking from the posterior area; in addition the whole surface is very finely pustulose and crossed by very indistinct growth-lines.

Length 42, height 30, diameter of the left valve 7.00 mm.

The *Cyathodonta gatunensis* Toula of the Canal Zone is a similiar but larger species, reaching a length of 52 mm. It differs from the Costa Rican species in its greater proportional length, the more central beaks and in its sculpture, which according to Toula's figure is strictly concentric.

The *C. undulata* Conrad, a recent species from the Gulf of California, is sculptured like *Tristani* with oblique riblets but the left valve is depressed and strongly flattened.

This species is named for Professor J. Fidel Tristan, Director of the National Museum of Costa Rica.

Gatun Stage: Rio Betey.

ORDER TELEODESMACEA

Genus **CRASSATELLITES,** Kruger

Crassatellites Reevei Gabb Plate 20, figure 4

Crassatella antillarum Reeve ? *C. Reevei* Gabb 1873, Trans. Amer. Phil. Soc. vol. 15, p. 252.

Crassatellites reevei Brown and Pilsbry, 1913, Proc. Acad. Nat. Sci. Phila., vol. 64, p. 515, pl. 23, fig. 5.

The *Crassatellites Reevei* Gabb is not an uncommon fossil in the Gatun beds of western Panama and Costa Rica. Our specimens agree quite closely with Brown and Pilsbry's figure of the single right valve collected by Gabb in the Miocene of Santo Domingo. Young and full-grown specimens show a strong posterior angulation which extends from the beak to the posterior ventral extremity. The posterior end is obliquely truncated but less so in young shells. The surface sculpture consists of even, concentric costæ which on the slightly flattened umbos are a little wider apart as in the *Crassatellites* of the section *Scambula* Conrad. In this later character, our shells disagree with Brown and Pilsbry's redescription of Gabb's type specimen, in which the sculpture is said to extend without any irregularity upon the rather flattened umbos.

The *C. mediamericanus* Brown and Pilsbry from Sapote, Costa Rica is an earlier shell and is higher, less obliquely truncated behind, more coarsely sculptured and lacks the posterior angulation. In these characters except the lack of the posterior-umbonal angulation it is like the young shells of *Reevei.*

Length	55,	height	36.5,	semi-diameter	10.5	mm.
	50		35	diameter	21	mm.
	58		42	semi-diameter	14	mm.

Gatun Stage: Water Cay.
Old Man Sam Creek, Coll. No. 6.
Banana River.

Subgenus **CRASSINELLA**, Guppy

Crassatellites bowdenensis Dall, variety **costaricensis, n. var.**

Plate 29, figure 12

Cf. *Crassatellites* (*Crassinella*) *bowdenensis* Dall, 1903, Trans. Wagner Free Inst. Sci., vol. 3, pt. 6, p. 1476, pl. 50, figs. 2, 3.

Shell small, triangular, slightly convex, subequilateral, the anterior end generally a little longer and more pointed; beaks triangular, slightly pointing forwards; lunule large, narrowly lanceolate, smooth; escutcheon small; surface sculptured with small, even, concentric riblets which on some shells may be strong and persistent over the greater part of the shell, or on some specimen sub-obsolete; interior of shell cavity shallow, with a moderately heavy hinge.

Length 3.00, height 2.75, diameter .75 mm.
3.50, 3.50, .75 mm.

The typical *bowdenensis* Dall from the Bowden Miocene of Jamaica is a more solid, more convex and triangular shell. The variety *costaricensis* is very abundant at several localities in Costa Rica in certain horizons. The sculpture varies from strong, even, concentric riblets covering the greater part of the shell, to forms which are nearly smooth.

Gatun Stage: Hill 1a, Banana River.
Middle Creek.
Zone 3, Quitana Creek.

Crassatellites midiensis, n. sp. Plate 29, figure 11

Shell small, trigonal, slightly convex and equilateral; the beaks are central and erect; the dorsal margins straight and meeting at the beaks nearly at right angles; the surface is sculptured with subregular, distant, concentric lamellæ-like riblets, numbering about 10; the interspaces carry irregular, finer, concentric lines; lunule narrowly lanceolate, with the escutcheon narrow and smaller; interior of shell cavity shallow, with a moderately heavy hinge.

Length 3.25, height 3.25, diameter of one valve 1.00 mm.

A small, rare species, somewhat like the *C. Guppyi* Dall of the Miocene of Jamaica, but more trigonal, with more central beaks and somewhat different sculpture. The sculpture and form are very similar to specimens of *C. galvestonensis* Harris in the Cornell Collection from the Chesapeake Miocene of Yorktown, Va. This latter species is generally much worn but perfect specimens have a coarse concentric sculpture like that of *lunulatus* Conrad. The Costa Rican shells are however very much smaller.

Gatun Stage: Middle Creek, C. R.
Coll. 4, East Grape Point Creek.
Water Cay, Panama.

Genus **CARDITA**, (Bruguière) Lamarck

Cardita caribbeanensis, n. sp. Plate 26, figure 22

Shell small, moderately convex, elongate, its length a little less than twice its height; beaks very near the anterior end are small but distinct; an umbonal ridge extends from the beaks to the posterior-ventral extremity and along which and bordering the ribs are largest; the right valve with about 20, hight, narrow and sharply nodulose ribs, separated by wide, triangular, smooth interspaces; 6 of the ribs are situated on the posterior-dorsal submargins, and of which the 4th and 5th from the dorsal margin are much smaller than the others; of the remaining ribs, the largest are found on the umbonal ridge, and become progressively smaller anteriorly; lunule small but distinct; hinge of the right valve that of typical *Cardita*, with 3 cardinal teeth of which the middle one is much the largest, no laterals; ventral margin, internally fluted in harmony with the external ribs.

Length 18, height 12.50, diameter of the right valve 5.50 mm.

This small species represented by a single right valve in our collection appears to be a true *Cardita*, its hinge being essentially that of the recent West Coast *Cardita laticostata* Sowerby. With the exception of a few doubtful species in the Eocene of United States, true *Cardita* has heretofore not been found as a fossil in the Americas and its recent American species are confined to the Pacific coast.

Compared with the recent *Cardita laticostata* Sowerby, which is abundant along the Pacific Coast of Panama, the fossil shell differs in its smaller size, smaller umbos and in form. Its lunule is like that of *laticostata.*

Gatun Stage: Banana River.

Section **CARDITAMERA,** Conrad

Cardita matima, n. sp. Plate 32, figure 8

Shell robust, solid, strongly inequilateral with the beaks situated at the anterior extremity of the shell; umbos large and full with strongly curved beaks above the small, sunken lunule; outline of the shell from within is subrectangular with straight ventral and posterior sides which meet at nearly right angles; sculpture of about 18 strong, heavy cord-like ribs, separated by interspaces 1-3 of their width; the ribs are strongly nodulated on the disk and umbonal portion of the shell, but below they are simply irregularly wrinkled; a deep furrow extends from the beaks to the posterior extremity, just above the umbonal angle; the rib forming the summit of the ridge between the umbonal furrow and the hinge-line is larger than those on each side; shell cavity deep with a crudely denticulated ventral and posterior margin; hinge large (broken in our specimen), with a well-developed anterior lateral tooth in its left valve.

Length 30, height 25, semi-diameter 12 mm.

But a single specimen of this very distinct spceies was collected by Dr. A. C. Veatch from the Upper Gatun of Old Man Sam Creek in eastern Costa Rica. It differs from the other known American Carditameras by its convex shell and strongly curved beaks. The ribs are large and strongly nodulated at first, becoming irregularly wrinkled near the ventral margin. The hinge is unfortunately broken on our specimen, a left valve, but the small anterior lateral still remains which shows this shell to belong to the section *Carditamera*

Gatun Stage: Old Man Sam Creek, 1 mile south from shore.

Genus **VENERICARDIA**, Lamarck

Venericardia scabricostata Guppy Plate 32, figures 14, 17

Cardita scabricostata Guppy, 1866, Quart. Journ. Geol. Soc. London, vol. 22, p. 293, pl. 18, fig. 10.

Cardita scabricostata Gabb, 1873, Trans. Amer. Phil. Soc., vol. 15, p. 252.

Venericardia scabricostata Maury, 1917, Bull. Amer. Pal., vol. 5, p. 362, pl. 33, fig. 1.

This species originally described by Guppy from the Bowden beds of Jamaica is common in the Miocene of Costa Rica and frequently forms small zones in the Gatun beds. It occurs also in the Miocene of Santo Domingo.

The ribs numbering about 18 are high, narrow and strongly granulated. The interspaces are wide and generally smooth.

Gatun Stage: Zone E, G, Saury creek.
Zone 1, 3, East Grape Point creek.
Coll. 5, Red Cliff creek.
Headwaters of Middle creek.
Coll. C, Comadre creek.

Venericardia Terryi, n. sp. Plate 32, figures 12, 13

Shell of medium size, solid, moderately convex and sub-circular in form; beaks situated well forward and but slightly back of the extreme anterior end of the shell; the beak itself is small and loosely coiled over the small sunken lunule; sculpture consists of about 13, low, wide, smooth ribs which fit so closely together that there are no interspaces between them; the ribs are rounded in section on the umbos, wide and low ventally; the ribs are largest about the middle, small and fading away on the posterior and anterior dorsal submargins; interior concealed in a hard sandstone matrix.

Length 22, height 21, semi-diameter 6 mm.

The first specimens of this interesting species was collected by Mr. R. Terry from some Gatun sandstones in Quitana Creek, a small tributary streams of the Rio Betey. In that locality, it is an abundant species and occurs in small zones.

It is related to the recent Pacific, *V. crassicostata* Sowerby but is a much smaller species.

Gatun Stage: Quitana Creek.
Hill No. 3, Banana River.

Subgenus **PLEUROMERIS**, Conrad

Venericardia Conradiana Gabb, var. **limonensis**, n. var. Plate 26, figs. 19, 20

Cardita Conradiana Gabb, 1881, Journ. Acad. Nat. Sci. Phila., vol. 8, 2nd series, p. 377, pl. 47, fig. 79.

Shell small, subcircular, moderately convex; umbos high and prominent, with small, inconspicuous beaks at the anterior 1-3 of the shell; the sculpture consists of about 18 heavy, granulated ribs, separated by somewhat narrower interspaces; interior of the shell deep, the hinge with 2 cardinal teeth and a small posterior and anterior lateral.

Length 7.00, height 7.00, diameter of the left valve 3.00 mm.

Gabb specimen described from the Pliocene beds of the Limon Peninsula, measures 1½ mm in length. His enlarged figure is very similiar to the present shell, in its subcircular form and in number of ribs. The figure of the hinge shows the two cardinal teeth but no laterals.

The common *tridentata* Say of the Upper Chesapeake Miocene and recent fauna of the West Indies differs mainly in its more triangular form.

Gatun Stage: Port Limon.

Genus **CHAMA**, (Linné) Bruguière

Chama congregata Conrad — Plate 28, figure 11

Chama congregata Conrad, 1833, American Journal of Science, vol. 23, p. 341.

Chama congregata Conrad, 1838, Fossils of the Medial Tertiary, p. 32, pl. 17, fig. 2.

Chama congregata Dall, 1903, Trans. Wagner Free Inst. Sci., vol. 3, pt. 6, p. 1400.

Chama congregatoides Maury, 1917, Bull. Amer. Pal., vol. 5, p. 200, pl. 33, fig. 8.

Our specimens from Costa Rica are all small and belong to the upper or free valve, which in this species is the right. These specimens cannot be distinguished from true *congregata* of the same size from the eastern United States, where it is an abundant fossil throughout most of the Chesapeake Miocene. The upper or right valve is finely, radiately frilled or fluted and these frills are cut by the concentric lamellæ. The attached or left valve is more coarsely sculptured, both radially and concentrically.

Gatun Stage: Water Cay.
Coll. 4, Red Cliff Creek.

Genus **ECHINOCHAMA**, Fischer

Echinochama antiquata Dall — Plate 28, figure 8

Chama antiquata Guppy, 1866, Quart. Journ. Geol. Soc. London, vol. 22, p. 294. Not of Linné.

Echinochama antiquata Dall, 1903, Trans. Wagner Free Inst. Sci., vol. 3, pt. 6, p. 1404, pl. 54, fig. 9.

Not *Echinochana antiquata* Maury, 1917, Bull. Amer. Pal., vol. 5, p. 365, pl. 33, fig. 10. *E. yaquensis* Maury.

This species described by Dall from the Bowden beds of Jamaica differs from the common, recent *arcinella* Linné of the West Indies, by its more numerous, irregular and lower ribs which bear only small, short spines. In *arcinella* the middle ribs are heavy and bear large, stump-like spines and the wide interspaces are reticulated with a coarse, mesh-like sculpture.

Gatun Stage: Middle Creek,
Coll. 6, Old Man Sam Creek.
Hill No. 1, Banana River.
Rio Blanco.

Echinocama yaquensis Maury Plate 28, figure 5

Chama arcinella Moore, 1853, Quart. Journ. Geol. Soc. London, vol. 9, p. 130. Not of Linné.

Chama arcinella Gabb, 1873, Trans. Amer. Phil. Soc., vol. 15, p. 251.

Chama arcinella Guppy, 1874, Quart. Journ. Geol. Soc. London, vol. 32, p. 531.

Echinochama antiquata Maury, 1917, Bull. Amer. Pal., vol. 5, p. 365, pl. 33, fig. 10. Not of Dall.

Echinochama antiquata var. *yaquensis* Maury, 1917, *op. cit.* p. 365, pl. 33, figs. 11, 12,

Echinochama trachyderma Pilsbry and Johnson, 1917, Proc. Acad. Nat. Sci. Phila., p. 197.

The *Echinochama yaquensis* Maury from the Miocene of Santo Domingo, where it is the prevaling species, differs from the *antiquata* by the reduced number of its ribs, which in some cases are nearly obsolete and in having its surface covered with a coarse, mesh-like sculpture of raised pustules.

In Costa Rica, the *antiquata* is the common species, but we have also a single species of *yaquensis* collected from the lower Gatun near Old Harbor.

Gatun Stage: Old Harbor.
Gatun, C. Z.

Genus **DIPLODONTA**, Brown

Section **DIPLODONTA**, s. s.

Diplodonta collina, n. sp. Plate 32, figure 15

Shell small, subcircular, convex; umbos wide, with small inconspicuous beaks, slightly posterior of the middle; anterior and posterior extremities well rounded into the base forming a part of the same circle; surface sculptured with fine, even, concentric threads which are nearly lacking from the smooth umbos; hinge normal, and a plain ventral margin.

Length 6.75, height 6.75, diameter of the right valve 1.60 mm.

A small shell resembling the *Diplodonta nucleiformis* Wagner of the Upper Chesapeake Miocene and the recent West Indian fauna, but less convex and more finely sculptured.

Gatun Stage: Middle Creek.

Section **FELANIELLA**, Dall

Diplodonta insula, n. sp. Plate 32, figure 21

Shell small, slightly convex, subcircular; beaks slightly posterior of the middle so that the posterior is a little longer than the anterior; beaks low and inconspicuous; both anterior and posterior extremities widely rounded, the posterior and the ventral margin forming a part of the same circle; surface with fine, concentric threads heaviest on the extremities, but nearly lacking from the umbonal area; interior of shell shallow, the right valve with a strongly bifid posterior cardinal; ventral margin plain.

Length 6.60, height 6.50, diameter of the right valve 1.25 mm.

A small, subcircular shell, neatly sculptured with fine, concentric threads. *D. minor* Dall from the Bowden beds is strongly oblique.

Gatun Stage: Water Cay.

Genus **MYRTAEA**, Turton

Myrtaea limoniana Dall Plate 32, figures 11, 23

Myrtæa limoniana Dall, 1903, Trans. Wagner Free Inst. Sci., vol. 3, pt. 6, p. 1358, pl. 52, fig. 10.

A small, thin and slightly convex shell, its surface sculptured with fine, thin and sharp, elevated, concentric lamellæ. We have several specimens from the coral limestones of Port Limon as well as a larger specimen from Zone 4, of Red Cliff Creek. This later shell measures: heigth 9.50, length 10.00, diameter of the right valve 2.50 mm. It occurs also in the Bowden beds of Jamaica.

Gatun Stage; Port Limon.
Coll. 4, Red Cliff creek.

Genus **PHACOIDES**, Blainville

Subgenus **CALLUCINA**, Dall

Phacoides radians Conrad, var. **medioamericanus**, n. var. Plate 32 fig. 16

The *Phacoides radians* Conrad is a fossil of the Upper Chesapeake Miocene of the Carolinas but has continued through the Pliocene to the recent fauna. The Costa Rican fossils differ from typical *radians* in having their umbos sculptured with about 6 ribs much stronger than the concentric, while in typical *radians*, the ribs are more numerous and about equal to the concentric lines. The *medioamericanus* is also smaller as may be seen in the measurements given below, while *radians* is large (20 mm) and often quite convex.

Length 9.5, height 9, semi-diametes 2.5 mm.

Gatun Stage: Headwater of Middle creek.
Old Man Sam creek, 1 mile south of the beach.

Subgenus **HERE**, Gabb

Section **CAVILUCINA**, Fischer

Phacoides trisulcatus Conrad

Lucina trisulcata Conrad, 1841, Trans. Amer. Assoc. Nat. and Geol., vol. 1. p. 110.

Lucina trisulcata Conrad, 1845, Fossils of the Medial Tertairy, p. 71, pl. 40, fig. 5.

Phacoides (*Cavilucina*) *trisulcatus* Dall, 1903, Trans. Wagner Free Inst. Sci., vol. 3, pt. 6, p. 1369.

Few specimens from the Gatun of Middle Creek. They are identical with typical specimens from the Chesapeake Miocene of the eastern United States. The species also occurs in the recent fauna.

Gatun Stage: Middle creek.
Old Man Sam creek.

Subgenus **LUCINISCA**, Dall

Phacoides costaricensis, n. sp. Plate 32, figure 5

Shell subcircular, moderately thick and but slightly convex: beaks small and inconspicuous, a little in front of the middle; dorsal area impressed and well defined; sculpture consists of strong, regular, radial threads, widely separated by interspaces 2 or 3 times the width of the threads themselves; they are crossed by distant but regular concentric ridges, the intersection forming small beads or granulations, strongest on the anterior and posterior extremities; the lunule is narrow, lanceolate and with the concentric sculpture predominanting; interior of shell cavity rather shallow, the ventral margin coarsely serrated by the external sculpture.

Length 11.50, height 11.00, diameter of the left valve 2.25 mm.

This species is recognized by its depressed or but slightly convex shell and coarse sculpture, of which the radial is a little stronger. *Phacoides cribrarius* Say and *nassula* Conrad are both more convex, with the concentric lamellæ more distantly spaced on the umbos and dominating over the radial. *P. muricatus* Spengler of the West Indies is much more finely sculptured.

We have also a young shell from Water Cay which is possibly *P. nassula*, var. *caloosana* Dall of the Florida Pliocene. It is very close to specimens of that species in the Cornell collection.

Gatun Stage: Middle creek.

Phacoides bocasensis, n. sp. Plate 32, figure 6

Shell thin, subcircular, depressed; dorsal area well defined by a marked change in sculpture; beak small, but distinct, placed a little in front of the middle; the sculpture on the disk of the shell is fine, composed of subequal, radial threads, separated by narrow interspaces; the ribs and interspaces are crossed by fine, concentric threads or ridges which produce a finely scabrous surface; the concentric threads are a little more widely spaced on the umbos; the dorsal area is defined by a stronger radial, beyond which follows a wide radial band, strongly sculptured with the concentric threads or lamellæ but lacking in radials; the upper half of the dorsal band bears in addition to the concentric lamellæ, 2 or 3 weak but scabrous radial threads; the lunule is very narrow, lanceolate and with a few strong, concentric lamellæ; interior of the shell cavity shallow, with the ventral margin finely crenulated.

Length 10.00, height 9.25, diameter of the left valve 2.00 mm.

A depressed and very finely sculptured species whose general form is that of *P. muricatus* Spengler of the recent West Indian fauna. It is more regularly sculptured than the *P. hispan-*

iolana Maury of the Cercado formation of Santo Domingo but the main difference lies in their dorsal areas, that of *hispaniolana* Maury being sculptured more or less like the rest of the shell; in *bocasensis*, as described above, the sculpture of the dorsal area is dominantly concentric, only the upper half bearing 2 or 3, low but scabrous radials.

Gatun Stage: Bocas del Toro.

Subgenus **PARVILUCINA**, Dall

Section **BELLUCINA**, Dall

Phacoides actinus Dall Plate 32, figure 24

Phacoides (*Bellucina*) *actinus* Dall, 1903, Trans. Wagner Free Inst. Sci., vol. 3, pt. 6, p. 1385, pl. 52, fig. 3.

Dall gives for his typical specimens from the Bowden beds of Jamaica, a height of 4.50 mm, while the Panama shells, all from Bocas Island, do not exceed 3 mm in height but agree in other respects. It is also recorded by Maury from the upper part of the Cercado formation of Santo Domingo.

Gatun Stage: Bocas del Toro.

Genus **DIVARICELLA**, von Martens

Divaricella quadrisulcata d'Orbigny Plate 32, figure 20

Lucina divaricata Conrad, 1840, Fossils of the Medical Tertiary, p. 39, pl. 20, fig. 3, but not of Linné.

Lucina quadrisulcata d'Orbigny, 1846, Voy. Am. Mer., p. 584.

Divaricella quadrisulcata Dall, 1903, Trans. Wagner Free Inst. Sci., vol. 3, pt. 6, p. 1389.

Lucina (*Divaricella*) *quadrisulcata* Bose, 1906, Boll. de Inst. Geol. de Mexico, numero 22, p. 77, pl. 11, figs. 2, 3.

This species is very rare in Costa Rica. The shells are rather thin and generally more finely sculptured and approach in this respect the *D. compsa* Dall of the Florida Pliocene. Our larges specimen measures: height 14 m, length 10 mm, diameter of left valve 4.50 mm. The *D. prevaricata* Guppy of the Miocene of Santo Domingo and Jamaica measures only 8 mm in height.

The *D. quadrisulcata* is a recent species of the West Indies appearing in the east coast Miocene of the United States for the first time in the Upper Chesapeake.

Gatun Stage: Coll. 4, 5, Red Cliff creek.
Middle creek.

Genus **CARDIUM**, Linné

Subgenus **TRACHYCARDIUM**, Moerch

Cardium stiriatum Brown and Pilsbry Plate 27, figures 4, 5

Cardium (*Trachycardinm*) *stiriatum* Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. Phila., vol. 63, p. 366, pl. 28, fig. 11.

This is most elegant of the several species of *Cardium* in the Miocene of Panama and Costa Rica. The shell is high and inflated with about 30 radial ribs which are peculiarly sculptured with twisted or obliquely projecting tuberclers placed on the posterior side of the ribs and overhanging the adjacent interspace. Large specimens may reach a height 50 mm. It is related to the recent West Coast *Cardium belcheri* Broderip.

Gatun Stage: Gatun, C. Z.
Water Cay, Panama.
Hill No. 1, Banana River.

Cardium dominicense Gabb Plate 27, figure 2

Cardium)*Trachycardium*) *dominicense* Gabb, 1873, Trans. Amer. Phil. Soc., vol. 15, p. 25.

Cardium (*Trachycardium*) *dominicense* Gabb, 1881, Journ. Acad. Nat. Sci. Phila., 2nd series, vol. 8, p. 344.

Cardium (*Trachycardium*) *gatunensis* Toula, 1908, Jahrb. der K-K Geol. Reichsanstalt Wien, vol. 58, p. 720, pl. 27, fig. 4. Not *Cardium* (*Fragum*) *gatunensis* Dall, 1900.

Cardium (Trachycardium) dominicense Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. Phila., vol. 63, p. 367.

A large species abundant in the Canal Zone but usually only as internal casts. It appears to be rare in Costa Rica, our collection containing only a few fragments of a large individual from East Grape Point Creek. It is distinguished not only by its large size, but very numerous (60+) fine ribs.

Gatun Stage: Gatun, C. Z.
East Grape Point Creek, C. R.
Sapote, C. R. (Gabb)

Cardium costaricanum, n. sp. Plate 27, figure 3

Shell ovate, solid, inflated; umbos wide and full with high beaks; sculpture of about 24 strong ribs, rounded or subtriangular in section with their apex leaning posteriorly except those on the posterior slope which lean anteriorly; interspaces narraw, formed by the sides of the ribs; the ribs are mostly smooth except those on the anterior half of the shell which have their posterior side more or less granulated; this granulation is found also on a few of the central ribs near their ventral margin; hinge narrow; internal margin fluted in harmony with the external ribs.

Length 24.50, height 34, semi-diameter 15 mm.

This species is not uncommon in Costa Rica and may easily be confused with the *C. dominicanum* Dall. It differs in its larger side, narrow umbos, more pointed beaks and more flattened ribs.

Gatun Stage: Coll. 4, East Grape Point Creek.

Subgenus **FRAGUM**, Bolton

Cardium medium Linnæus Plate 27, figure 6

Cardium medium Linnæus, 1758, Sys. Nat. ed. 10, p. 678.
Cardium medium Reeve, 1844, Conch. Icon., *Cardium*, pl. 6. fig. 30.
Cardium (Fragum) medium Dall, 1900, Trans. Wagner Free Inst. Sci., vol. 3, pt. 5, p. 1101.

A recent West Indian species but also common as an Upper Miocene and Pliocene fossil along the Atlantic coastal plain of eastern United States. The ribs number 24 to 27 in front of the umbonal angle. Dall has described a *Cardium* (*Fragum*) *gatunensis* from Gatun, on which the ribs number only 16 in front of the truncation and 10 behind.

Gatun Stage: Port Limon.

Section **TRIGONIOCARDIA** Dall

Cardium heredium, n. sp. Plate 27, figure 10

Shell small, solid, oblique, convex and subquadrate; strongly carinate on the posterior-umbonal slope and truncated; umbos high and prominent; shell sculptured anterior to the truncation with 12 or 13 strong ribs, separated by interspaces about ½ to ⅓ as wide; there are 7 or 8 smaller ribs on the posterior truncation; the interspaces are finely sculptured with small, elevated cross-threads; the anterior set of ribs on the type specimens are wide, subequal and smooth; the posterior are unequal, with the three, bordering the umboal angulation much the smaller and bearing small and scattered pustules; on the posterior ribs where the pustules are lacking, are small dot-like depressions.

Height 11.50, length 11.50, diameter 6.00 mm.

This species approaches the *Cardium apateticum* Dall from the Oak Grove sands of Lower Miocene age in Florida. It differs by its more oblique umbos and proportionately higher shell. The pustules are variously developed and on some shells are more strongly developed and may also appear on some of the ribs anterior to the truncation. These more strongly scalptured shells may prove with more material to belong to another species.

Gatun Stage: Rio Betey.
Banana River.
Estrella River.

Subgenus **PAPYRIDEA,** Swainson

Cardium spinosum Meuschen, var. **Turtoni** Dall Plate 27, figure 1

Cardium (*Papyridea*) *spinosum* var. *Turtoni* Dall, 1900, Trans. Wagner Free Inst., Sci., vol. 3, pt. 5, p. 1108.

The fossil shells from Costa Rica, are referrible to this variety of *spinosum*, distinguished by having the interspaces between the ribs marked with a flat thread, between sharp grooves. This variety is also found fossil in the Chesapeake Miocene at Jackson Bluff Florida and in the Pliocene Caloosahatchie beds of the same state. It the recent fauna it is confined, according to Dall, to the eastern Atlantic, with the typical *spinosum* in the West Indies and a third variety *aspersum* Sowerby along the Pacific side.

Gatun Stage: Port Limon.

Subgenus **LAEVICARDIUM,** Swainson

Cardium serratum Linnæus Plate 27, figures 11, 12

Cardium serratum Linnæus, 1758, Syst. Nat., ed. 10, p. 680.

Cardium (*Lævicardium*) *serratum* Dall, 1900, Trans. Wagner Free Inst. Sci., vol. 3, pt. 5, p. 1110.

Cardium (*Lævicardium*) *serratum* Brown and Pilsbry, 1911, Proc Acad. Nat. Sci. Phila., vol. 63, p. 367.

Cardium (*Lævicardium*) *serratum* Maury, 1917, Bull. Amer. Pal., vol. 5, p. 376, pl. 36, fig. 8.

Most of the fossil shells are indistinguishable from recent examples of *serratum* from the West Indies. Others shells are decidely oblique and approach in form the *C. sublineatum* Conrad of the Upper Chesapeake Miocene of eastern United States. The *C. venustum* Gabb from the Miocene of Santo Domingo is very distinct from *serratum* and characterized by its faintly flexuous outline, strong radial striæ, and in having the lower cardinal tooth large and strong.

Gatun Stage: Gatun, C. Z.
Middle Creek. C. R.
Rio Betey, C. R.

Genus **PROTOCARDIA**, Beyrich

Protocardia costaricensis, n. sp. Plate 27, figure 13

Shell small, rather thin, convex; beaks a little anterior to the middle, with high, inflated umbos; the anterior end is widely rounded, the posterior somewhat truncated; the posterior area is well differentiated and occupies the posterior one-third of the shell and is sculptured with numerous small radial threads separated by wider interspaces; these interspaces are finely sculptured with cross-threads; anterior of the posterior area the shell surface is sculptured with small radial threads which are finely beaded; on the anterior end of the shell, the beading is more irregular and is seen to be made by the concentric sculpture.

Height 18, length 21, diameter of the left valve 7 mm.

This species differs from both *P. jamaicensis* Dall from the Bowden beds of Jamaica and *P. islahispaniolæ* Maury from the Miocene of Santo Domingo by its smaller posterior area. It approaches more closely the Dominican shell but is shorter and more coarsely sculptured.

The *P. Newberryana* Gabb from Gatun is based on a large internal cast which is entirely unrecognizable.

Gatun Stage: Comadre creek.

Subgenus **LOPHOCARDIUM**, Fischer

Protocardia gurabica Maury Plate 27, figures 7-9

Protocardia gurabica Maury, 1917, Bull. Amer. Pal., vol. 5, p. 377, pl. 36, fig. 10.

Shell thin, inflated, a little longer than high and with the greatest convexity about the center of the shell; the umbos are high, prominent and wide, and project well above the hinge margin; the anterior end is well rounded into the base; the posterior end is more contracted and gaping slightly at its extremity; surface sculpture on the body of the shell, anteriorly consists of narrow, concentric wrinkles which are best developed on the anterior end but become obsolete on the middle of the shell and posteriorly; in addition the whole surface carries fine, sub-obsolete radial threads; on the posterior area, the sculpture is of heavier and coarser radial threads, lacking the concentric, except the irregular growth lines.

Height 56, length 32, diameter 20 mm.

The subgenus *Lophocardium*, of which there are two recent species along the West Coast of Mexico, differs from the true *Protocardia*, in its gaping posterior end and lack of lateral teeth as well-as in important difference in its anatomical structure. The shells are strongly convex, with high, inflated umbos and are extremily thin and fragile.

The *P. gurabica* was described by Dr. Maury from the Gurabo formation of Santo Domingo, and compared by her with the Vickburgian *P. diversa* Conrad, but it appears to me to be a typical *Lophocardium* and representing the first member of this interesting subgenus to be found in the fossil state. As her specimen is very fragmentary, I have redescribed the species from better preserved Panama and Costa Rican material. The posterior end is gaping and the internal mold shows no impression of lateral teeth along the hinge margin. It approaches closely the *L. Annettæ* Dall, dredged from 8 to 27 fathoms in the Gulf of California, except that it is proportionately longer and lacks the concentric wrinkles on its posterior area. The *L. Cumingi* Broderip, the type of the subgenus, carries between its posterior area and the general surface of the shell, a thin radial lamina or crest, extending from the umbos to the ventral margin.

The fossil shell is extremily thin. It generally occurs simply as internal molds which may still retains a part of the shell or impression of its sculpture on its surface.

Gatun Stage: Gatun, and Mt. Hope, C. Z.
Water Cay.
Margarita Trail, C. R.

Genus **DOSINIA,** Scopoli

Section **DOSINIDEA,** Dall

Dosinia acetabulum Conrad Plate 31, figure 1

Artemis acetabulum Conrad, 1833, Fossils of the Tertiary Formations, p. 20, pl. 6, fig. 1.

Dosinia acetabulum Bose, 1906, Boll. de Inst. Geol. de Mexico, numero 22, p. 81, pl. 11, figs. 7, 11.

Dosinia (*Artemis*) cf. *acetabulum* Toula, 1908, Jahrb. der K-K, Geol. Reichsanstalt, Wien, vol. 58, p. 727, pl. 27, figs. 8, 8a.

The *Dosinia acetabulum* has been recorded by Bose from Mexico and by Toula from Panama, but their determinations were based on imperfect material or casts. The Costa Rican collection however contains a large series of finely preserved Dosinias which are unquestionably the *Dosinia acetabulum* Conrad of the Chesapeake Miocene.

The surface of the Costa Rican specimens are generally neatly sculptured with even, concentric bands or ribbons which on the middle of the shell disk average 2 mm in width. The form of the shell is subcircular and like the typical *D. acetabulum* of the Yorktown formation of Virginia and North Carolina. The Costa Rican shells are equally as large as the Chesapeake shell measuring in height 70 mm or more.

The *Dosinia acetabulum* in the eastern United States, is a most characteristic fossil of the Chesapeake Miocene, where its range extends throughout most of the lower and upper Chesapeake formations. It is lacking from the Lower Miocene or the Alum Bluff formation of Florida, as well as from the succeeding Pliocene. In its range through the Chesakeake Miocene, it gives rise to several well-marked varieties of which the broad subcircular shell of the Upper Chesapeake is the typical form. The Costa Rican shells are most like the Upper Chesapeake typical *acetabulum*.

Brown and Pilsbry have described a smaller and more finely sculptured species from the Gatun Spillway as *delicatissima*. This spceies is represented in our collection from the same place and appears to be distinct. Toula's specimen from Gatun, however, is a true *acetabulum*.

The *Dosinia acetabulum* is a common fossil in the Gatun beds of Costa Rica, where it occurs most abundautly in the lower part of the formation.

Gatun Stage: Gatun, C. Z.
Hotel and Hone Creek.
Pumbri Creek.
Hill No. 3, Banana River.
Coll. 6, Estrella River.

Genus **CLEMENTIA**, Gray

Clementia dariena Conrad Plate 31, figure 4

Meretrix dariena Conrad, 1856, Pacific R. R. Reports, vol. 5, p. 328, pl. 6, fig. 55.

Clementia dariena Gabb, 1881, Journ. Nat. Sci. Phila., vol. 8, p, 344, pl. 44. fig. 16.

Clementia dariena Dall, 1903, Trans. Wagner Free Inst. Sci., vol. 3, pt. 6, p. 1235.

Clementia dariena Toula, 1908, Jahrb. der K-K. Geol. Reichsanstalt, vol. 58, p. 725, pl. 27, figs. 9, 10.

Clementia dariena Hubbard, 1920, Scientific Survey of P. R. and the Virgin Islands, vol. 3, pt. 2, p. 118, pl. 19, figs 10-12.

This species is very common in the lower Gatun of the Canal Zone. It is very rare in western Panama and in Costa Rica, where it occurs in the lower part of the Gatun formation and in the Uscari shales. Romanes* has recorded it from Barranca near Punta Arenas on the Pacific coast of Costa Rica, from beds probably equivalent to the Lower Gatun or to the Uscari.

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* Quart. Journ. Geol. Soc. London, 1912, vol. 68, p. 125.

The shell is very thin and fragile, and hence the specimens are very frequently much crushed and distorted in shape. Typically the shell is broad and high, the beaks anterior in position and the surface sculptured with narrow, wave-like undulations which are best developed on the umbos.

Length 70, height 60. diameter 34 mm (Sousi Creek).

Uscari Stage: Sapote, C. Z. (Gabb)
Gatun Stage: Gatun, C. Z.
Nancy's Cay, Prov. of Bocas del Toro.
Upper Hone Creek, and its tributary Sousi Creek.

Genus **GAFRARIUM**, Bolton

Section **GOULDIA**, C. B. Adams

Gafrarium limonensis, n. sp. Plate 32, figure 18

Shell small, subcircular, moderately convex, umbos inflated, beaks anterior to the middle: surface finely sculptured with even, concentric riblets, more or less cancellated by fine, radial threads which are strongest on the anterior and posterior extremities, while the concentric riblets predominate on the middle of the shell; lunule distinct, narrowly lanceolate; interior of the shell deep, the hinge of both valves with 3 cardinal teeth and an anterior lateral; ventral margin concentrically grooved but not tangentially as in *Transenella*.

Length 4.75, height 4.25, diameter of the left valve 1.50 mm.

This small *Gouldia*, is fairly abundant in the Miocene coral limestones of Port Limon, and is characterized by its small, convex shell and subcircular form. Gabb has described a small *Gouldia* from the Pliocene beds of the Limon Peninsula, but that species is more depressed, less circular and more trigonal in outline. Gabb's species may prove to be but a small form of the recent West Indien *G. cerina* C. B. Adams,

Gatun Stage; Port Limon.

Old Man Sam creek, 1 mile south of the beach.

Gafrarinm altum Dall, va. **costaricensis**, n. sp. Plate 32, figures 19, 22

cf. *Gafrarium altum* Dall, 1903, Trans. Wagner Free Inst. Sci., vol. 3, pt. 6, p. 1249, pl. 57, fig. 5,

Shell small, high, rounded trigonal, moderately convex; beaks small and pointed slightly forward, in young shell nearly central but becoming with maturity slightly anterior; anterior and posterior extremities nearly similiar and evenly rounded; surface with fine, concentric lines, most distinct and even towards the ventral margin, and with faint, radial striæ on the anterior and posterior slopes; lunule large, lanceolate, defined by an impressed line; interior of shell deep, with a concentrically grooved margin.

Length 4.85, height 4.75, diameter of right valve 1.50 mm.

The Costa Rican shells differ from the typical *altum*, described by Dall from the Oak Grove sands of Florida, in being more trigonal in form and with higher beaks. The sculpture of its surface is mainly concentric, the radials showing only as very faint striæ on the posterior and anterior extremities.

Gatun Stage: Middle creek.

Coll. 6, Estrella River.

Genus **MACROCALLISTA**, Meek

Section **CHIONELLA**, Cossmann

Macrocallista maculata Linnæus Plate 31, figures 6, 7

Venus maculata Linnæus, 1758, Syst. Nat., ed. 10, p. 686, ed. 12, p. 1132.

Cytherea dariena Conrad, 1857, Pacific R. R. Report, vol. 6, p. 72, pl. 5, fig. 21.

Callista maculata Gabb, 1881, Journ. Acad. Nat. Sci. Phila., 2nd series, vol. 8, p. 372.

Macrocallista (*Chionella*) *maculata* Dall, 1903, Trans. Wagner Free Inst. Sci., vol. 3, pt. 6, p. 1256.

Macrocallista maculata Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. Plila., vol. 63, p. 370.

The *Macrocallista maculata* is a common and widely distributed fossil in the Costa Rican Miocene and is readily recognized by its depressed, porcellaneous and highly polished shell. In the usual sandy phases of the Gatun, the species is quite typical, but becomes high and broad in the coralline or transitional phase.

A variety *cuneata* has been proposed by Gabb to include shells in which this posterior-dorsal slope is straight and not *humped* as usual. We have seen no examples of this type.

The *Macrocallista maculata* is a common recent species of the West Indies, appearing for the first time, in the lower Miocene beds of the Chipola River, Florida.

Gatun Stage: Headwaters of Middle creek.
Rio Blanco.

Genus **CALLOCARDIA**, A. Adams

Subgenus **AGRIOPOMA**, Dall

Callocardia gatunensis Dall Plate 32, figure 1

Callocardia (*Agriopoma*) *gatunensis* Dall, 1903, Trans. Wagner Free Inst. Sci., vol. 3, pt. 6, p. 1260, pl. 54, fig. 1.

Callocardia (*Agriopoma*) *gatunensis* Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. Phila., vol. 63, p. 370.

A convex, cordate shell very abundant in the Gatun beds of the Canal Zone, especially in the quarries at Mt. Hope. It is a rare species in Costa Rica, but generally larger, more triangular in outline and somewhat coarsely sculptured. These shells are nearest to Dall's variety *multifilosa*.

Dall also records the species from the Miocene of Santo Domingo and Jamaica.

Gabb's *C. sapotensis*, from Sapote, Costa Rica, we have not seen. It is a higher and more Dosinoid shell with nearly central beaks. It is possibly but a variety of this species.

The following measurements are of Costa Rican examples:

Length 46, height 28, thickness 35 mm.
53, 44, 16 mm (right valve)

Gatun Stage: Gatun and Mt. Hope, C. Z.
Hill No. 1, Banana River.
Sousi Creek (Upper Hone creek).

Genus **PITARIA**, Roemer

Section **LAMELLICONCHA**, Dall

Pitaria circinata Born Plate 31 figures 3, 9

Venus circinata Born, 1780, Test. Mus. Vind. p. 61, pl. 4, fig. 8.

Cytherea alternata Broderip, 1835, Proc. Zool. Soc., p. 45.

Cytherea juncea Guppy, 1866, Quart. Journ. Geol. Soc. London, vol. 22, p. 682, pl. 26. fig. 13.

Chione circinata Gabb, 1873, Tarns. Amer. Phil. Soc., vol. 15, p. 250.

Cytherea juncea Guppy, 1876, Quart. Journ. Geol. Soc. London, vol. 32, p. 531.

Pitaria (Lamelliconcha) circinata Dall, 1903, Trans, Wagner Free Inst. Sci., vol. 3, pt. 6, p. 1269.

Pitaria circinata Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. Phila. vol. 63, p. 370.

Pitaria (Lamelliconcha) circinata Maury, 1917, Bull. Amer. Pal., vol. 5, p. 379, pl. 37, fig. 1.

The *Pitaria circinata* Born is a common, recent Veneroid along the Caribbean coast of Panama and Costa Rica. It occurs also on the west or Pacific side but in a slightly different form, as the variety *alternata* Broderip. This variety differs from the typical *circinata* by its larger, more convex shell and more distant concentric ribs.

The fossil shells from Costa Rica are generally more like the West Coast *alternata*, but are smaller and with somewhat more pointed beaks. The species is also found as fossil, in Santo Domingo, Trinidad and Venezuela.

Gatun Stage: Gatun, C. Z.
Zone E. Saury Creek, C. R.

Pitaria Hillii Dall, var. **musanica**, n. var, Plate 31, figure 5

Shell elongate, moderately convex and rather solid; beaks situated at the anterior ⅓, with the anterior extremity widely rounded but obtusely pointed posteriorly; lunule small, ridged in the middle and defined by a faint line; posterior-dorsal area broad and flat; surface of the shell sculptured with low, irregular, rounded, concentric ribs, which are persistent along the posterior-dorsal slope but lacking elsewhere near the ventral margin; interior of shell unknown.

Length 42, height 27, thickness (left valve) 10.50 mm.

This species has a solid shell like that of *Macrocallista*. It differs from the true *Hillii* described by Dall from the Gatun of the Canal Zone, by its more rude and irregular concentric sculpture.

The *P. planivieta* Guppy, from the Miocene of Jamaica and Santo Domingo is a much shorter and more regularly sculptured shell.

Gatun Stage: Hill No. 2, Banana River, C. R.

Pitaria Guppyana Gabb Plate 31, figure 11

Caryatis Guppyana Gabb, 1881, Journ. Acad. Nat. Sci. Phila., 2nd series, vol. 8, p. 373, pl. 47, fig. 73.

Shell small, ovate, moderately convex and porcellaneous; dorsal side straight; ventral side gently convex; posterior extremity sub-truncate but wide, meeting the dorsal side nearly at right angles; anterior extremity much narrower, produced and rounded; lunule narrowly lanceolate, sculptured with the continuation of the concentric ribs and separated from the shell disk by an impressed line; surface of disk sculptured with rather wide, low or appressed ribs formed between incised lines, but the shell as a whole is porcellaneous and smooth; as the ribs pass over the dorsal-posterior area towards the dorsal margin they decrease in number through fusion; interior concealed in a hard matrix.

Length 32, height 18, diameter (right valve) 5 mm.

A small species of the coralline limestones and marls of the Limon Peninsula, from which it was described by Gabb. It approaches the *P. planivicta* Guppy of the Miocene of Jamaica and Santo Domingo but is smaller and more rectangular in outlines. It is rather convex with a smooth and polished surface and with regular, even, concentric ribs.

Gatun Stage: Port Limon.

Pitaria VanWinkleæ, n. sp. Plate 32, figure 2, 3

Shell elongate, depressed; anterior extremity broadly rounded, posterior more acute; lunule small, lanceolate and defined by an impressed line; escutcheon long and very narrow; surface sculptured with narrow, closely spaced and reflected ribs; these ribs which number about 100 on the shell disk are even on the center of the shell, but generally uneven on the anterior extremity; the ribs are continuous from the edge of the escutcheon to the anterior dorsal margin; the rounded posterior dorsal slope carries two small, faint rows along which the concentric ribs are slightly higher and occasionally raised into small incipient spines.

Length 41.5, height 32, diameter (left valve) 10 mm.

This species is quite similiar to the *P. rosea* Broderip and Sowerby of the West Coast in its depressed shell and general form. The concentric ribs are very regular, even and continuous across the entire surface of the shell. Where these ribs cross the posterior-dorsal slope, they occasionally become raised into two rows of incipient spines. In *P. rosea* there is only one row of incipient spines and the dorsal-posterior area is smooth.

This species is named for Miss Katherine VanWinkle of the Paleontological Department of Cornell University and who is at present engaged on a Monograph of the American species of *Veneridæ*.

Gatun Stage: Hill No. 3. Banana River, C. R.

Pitaria boucaryensis, n. sp. Plate 31, figure 10

Shell rounded quadrate, thin and moderately convex; posterior and anterior extremities rounded, umbos rather large; lunule small and feebly defined by a faint, impressed line; surface of disk sculptured with about 40 even, distant, concentric lamellæ; interspaces generally smooth or irregularly sculptured with growth lines; interior of shell concealed.

Length 31, height 22, diameter (right valve) 10 mm.

As the single type specimen is fragmentary and imbedded in a hard sandstone, the above measurements are but approximate. It is a very distinctive species, differing from the other fossil Costa Rican Pitarias by its more delicate and convex shell and more distant, even, concentric lamellæ.

Gatun Stage: Boucary creek, C. R.

Genus **ANTIGONA**, Schumacher

Antigona multicostata Sowerby Plate 30, figure 1

Venus multicostata Sowerby, 1835, Proc. Zool. Soc., p. 22.
Venus multicostata Reeve, 1863, Conch. Icon., vol. 11, pl. 3, fig. 9.
Cytherea (*Cytherea*) *multicostata* Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, p. 390.

This is a large species living on the south or Pacific side of the Isthmus. A perfect specimen was collected from the Gatun beds of Water Cay, identical in every respect with recent examples from the Bay of Panama. It is another instance among the many which we have had occasion to note in the course of the present study of the occurrence of West Coast species in the Caribbean Miocene, proving conclusively from a purely paleontological standpoint the rather late separation of the Atlantic and Pacific through the final uplift of the isthmian lands.

The recent *A. Listeri* Gray is a smaller, more elongate species and with finer and sharper concentric lamellæ.

Length 107 mm, height 102 mm, diameter 69 mm.

Gatun Stage: Water Cay.

Antigona tarquina Dall Plate 30, figure 10

Venus magnifica Gabb, 1673, Trans. Amer. Phil. Soc., vol. 15, p. 249. Not of Sowerby, 1853.

Cytherea tarquina Dall, 1900, Trans. Wagner Free Inst., vol. 3, pt. 5, pl. 38, figs. 2, 2a; vol. 3, pt. 6, p. 1274.

Antigona tarquina Dall, 1915, Bull. 90, U. S. Nat. Mus., p. 147.

Antigona tarquina Maury, 1917, Bull. Amer. Pal., vol. 5, p. 381. pl. 37, fig. 4.

A small shell identical or closely related to *A. tarquina* Dall was collected from Zone 3 of Saury Creek. It is similiar to Dr. Maury's specimen of *A. tarquina* from Santo Domingo.

Typical *A. tarquina* Dall is a common fossil of the *Orthaulax pugnax* fauna of the Tampa Silex beds of Florida. It was also collected by Professor Gabb and Dr. Maury from the Miocene of Santo Domingo.

Gatun Stage: Zone E, Saury creek, near Cahuita, C. R.

Section **VENTRICOLA.** Roemer

Antigona rugosa Gmeiln Plate 30, figure 4

Venus rugosa Gmelin, 1792, Syst. Nat., p. 3276.

Venus rugosa Reeve, 1863, Conch. Icon., vol. 11, pl. 7, fig. 23.

Several specimens from the coralline limestones of Port Limon. They are practically identical with recent examples of *A. rugosa* from the West Indies. This species is distributed throughout the West Indies but is also found living in the Gulf of California. This distribution on both sides of the Isthmus is in harmony with its occurrence as a Miocene fossil.

Gatun Stage: Port Limon.

Antigona Blandiana Guppy Plate 30, figures 5, 6

Venus Blandiana Guppy, 1874, Geol. Mag., London, Decade ii, vol. 1, p. 436, pl. 17, fig. 6.

Cytherea (*Ventricola*) *Blandiana* Dall, 1903, Trans. Wagner Free Inst. Sci., vol. 3, pt. 6, p. 1277.

Antigona (*Ventricola*) *Blandiana* Maury, 1917, Bull. Amer. Pal., vol. 5, p. 381, pl. 37, fig. 5.

This species was described by Guppy from the Bowden beds of Jamaica but also collected by the Maury expedition in the Miocene of Santo Domingo. Dall also records it from the lower Miocene of the Chipola beds and from Curacoa, Dutch West Indies. It is a small species of nearly circular outlines and sculptured with distant primary lamellæ and finer secondary threads in the interspaces.

Our Costa Rican shells consist of two specimens, one from the coral limestones near Port Limon, the other from the lower Gatun of Comadre Creek near Cahuita. They differ from Dr. Maury's specimens from Santo Domingo in having the primary set of lamellæ more distantly spaced and their interspaces more closely striated with the secondary threads.

Length 30, height 24, diameter 9 mm (left valves) Comadre.

Length 24, height 23, diameter 8.5 mm (left valve) Port Limon.

Gatun Stage: Comadre creek, near Cahuita.
Port Limon.

Antigona Harrisiana, n. sp. Plate 30, figure 3

Shell small, convex and nearly circular in outline; umbos full with the beaks situated a short distance in front of the middle; lunule small but broadly cordate and sculptured with the continuation of the concentric ribs and lamellæ; escutcheon lanceolate, bordered by an angled ridge from the shell disk; disk sculptured with about 28 even, concentric ribs which appear as close undulations of the shell surface; the ribs and interspaces are in addition sculptured with fine lamellæ-like threads, each finely crenulated or radially striated; these lamellæ vary in size, those of the interspaces or troughs between the ribs are fine and 5 in number, with 2 large ones forming the tops of the ribs themselves, so that the ribs appear as if mesially divided; the radially striated character of the ribs and lamellæ is much stronger on the anterior and posterior submargins; interior of the shell deep but concealed by matrix in the type specimens.

Length 21.5, height 19.5, diameter 6.25 mm (right valve).

This elegant species occurs in the coralline phase of the Gatun formation in Costa Rica. Its relations are with the *A. Blandiana* Guppy and the recent *A. strigillina* Dall, but differs from both in its more elegant sculpture. This sculpture consists of close, regular, wave-like undulations or ribs, the crests of which carry 2, low laminæ, the troughs or interspaces, 5 or 6 finer threads. These fine thread-like laminæ are delicately etched with fine radial striations.

It is named for Professor G. D. Harris of the Paleontological Department of Cornell University.

Gatun Stage: Port Limon.

Genus **CYCLINELLA**, Dall

Cyclinella beteyensis, n. sp. Plate 31, figure 2

Shell thin, Dosinoid or sub-circular in form, the margins of the shell nearly a perfect circle; slightly convex; beaks small but distinct, situated at the anterior ⅓ of the shell ; sculpture with very fine, concentric threads, which are a little elevated and strongest on the anterior end, nearly smooth on the middle; lunule small, lanceolate and defined by a small, incised line; hinge normal, the left valve with 3, narrow; cardinal teeth and a wide ligament.

Height 39, length 38? diameter 5 mm left valve.

Represented by a single, imperfect specimen from the Gatun of Rio Betey. It is but slightly convex, and in form approaches very closely a species in the Newcomb collection from the Bay of Fonseca, which is probably the C. *Kroyeri* Philippi. The fossil shell is more perfectly circular in form.

Gatun Stage: Rio Betey.

Cyclinella subquadrata Hanley, var. **quitana**, n. sp. Plate 31, fig. 8

Shell small, thin, convex and subcircular in form; beaks small but distinct, with inflated umbo and small beak situated at the anterior ⅓; the anterior end is narrow and slightly produced, while the posterior end is wide and with the hinge-margin is subquadrate in form; the surface is sculptured with fine, irregular, concentric growth-lines, which are strongest and more regular on the posterior dorsal submargin; the interior is concealed.

Height 28, length 31, diameter of the right valve 7 mm.

This is a smaller and more convex species than the *beteyensis* and like that species, it seems to find its recent analogue on the Pacific side, in this case the *C. subquadrata* Hanley. On the Pearl Islands in the Bay of Panama I collected a few small valves which are probably the *C. subquadrata* Hanley, but they are not so produced anteriorly as is shown in Reeve's figure. These Pearl Island shells are very similiar to the Costa Rican fossil, differing mainly in their more inflated umbos and in slight difference in form.

From the Gatun beds of the Canal Zone, Dall has described *C. gatunensis*, but that species is very distinct from the two Costa Rican Cyclinellas.

Gatun Stage; Quitana creek.

Genus **CHIONE,** Megerle von Mühlfeld

Chione Rowleei, n. sp. Plate 30, figure 2

Shell rather large, convex, ovate; lunule broadly cordate and concentrically sculptured; escutcheon long, narrow, smooth and defined by a small cord-like ridge; surface of the disk with about 30 slightly elevated concentric ribs which on the umbos are thin and lamellar but lower on the shell disk are wide and trianglar at the base, but with a thin zigzag or fluted lamellar ridge on top; the interspaces, much wider on the umbos is sculptured with even rib-like cords which also flute in harmony the dorsal face of the concentric ribs; the ventral face of the ribs are finely striated by radial incised lines which form cord-like ridges along ½ as wide as the radial cord of the interspaces; interior of the shell deep, with a small pallial sinus and subequal adductor scars; basal margin finely crenulated as well as the lunular margin and the extreme posterior extremity.

Length 42, height 37.5, thickness (right valve) 17 mm.

This large, elegant *Chione* is quite common in the Gatun beds of Costa Rica. It also occurs in the lower Gatun at Gatun, usually in the form of casts. It recalls in a general way, the recent West Coast *C. amathusia* Philippi, but differs in its heavier shell, higher and fuller umbos and difference in details of its spiral and radial sculpture. In the Costa Rican shell, the radial cords are simple, relating it more closely with the small *C. Woodwardi* Guppy of the Miocene of Jamica and Santo Domingo, while in *C. amathusia*, they are double and alternating.

The *C. tegulum* Brown and Pilsbry we have not seen. It is a smaller shell, related to the *C. Woodwardi*. In *C. tegulum* the concentric lamellæ are much closer and the wide cordate lunule is sculptured only with radial lamellæ.

It is named for Professor W. W. Rowlee, who collected a few specimens from the Banana River in the course of botanical investigation of the Balsa tree (Genus *Ochroma*), a very light wood used in the construction of life-buoys, etc.

Gatun Stage: Gatun, C. Z.
Banana River.
Coll. 6, Estrella River.

Chione costaricensis, n. sp. Plate 32, figure 4

Shell of moderate size, convex, ovate-trigonal; the dorsal portion of the type specimen is lacking; the surface is sculptured with fine, subregular, concentric lamellæ spaced on the center of the shell disk about .75 mm apart; the interspaces and the ventral surfaces of the lamellæ are marked with regular, incised lines forming radial bands of an average width of .40 mm; a faint radial sinus extends from the beaks to the posterior; ventral margin of the shell is slightly arcuate at its posterior end; interior of ventral margin finely crenulated.

Length 34, height 29, diameter of the right valve 10 mm.

This shell will be distinguished from the other Costa Rican Chiones by its more crowded, concentric, lamellæ and regular, radial striæ. The striæ occur on the ventral faces of the lamellæ and on their interspaces.

Gatun Stage: Hill No. 3, Banana River.

Section **LIROPHORA**, Conrad

Chione mactropsis Conrad Plate 30, figures 7, 8

Gratelupia? mactropsis Conrad, 1856, Pacific R. R. Reports, vol. 5, p. 328, pl. 6, fig. 54.

Chione (*Lirophora*) *mactropsis* Dall, 1903, Trans. Wagner Free Inst. Sci., vol. 3, pt. 6, p. 1294.

Chione (*Lirophora*) *mactropsis* Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. Phila., vol. 63, p, 369.

Chione (*Lirophora*) *ulocyma* Brown and Pilsbry, 1911, *Idem*, p. 369. Not of Dell. 1903.

Until the construction work on the Panama Canal had commenced in earnest, the abundant and finely preserved fossils of the Canal Zone, so easily obtained at the present time, were not available, and the only fossil remains collected by the early travellers were generally in the form of poorly preserved casts. In 1856 there appeared in the Pacific Rail Road Reports, the description of an internal cast as *Gratelupia? mactropsis*, together with scarsely recognizable *Turritella gatunensis* and *altilira.*

These specimens obtained by Mr. W. P. Blake from the Isthmus are the first noticed from the fossiliferous rocks in Panama and Central America.

The *Lirophora mactropsis* described by Conrad from an internal cast as *Gratelupia ?*, is one of the most abundant fossils in the Gatun beds of the Canal Zone, associated with the smaller and more finely sculptured *holocyma* Brown and Pilsbry. *L. mactropsis* is a species of variable size, but moderately convex, longer posteriorly and usually with the basal margin more or less arcuated about the posterior extremity. The sculpture consists of irregular, more or less confluent concentric lamellæ, which are overrun by fine radial lines. These radial lines may remain strong or become obsolete as usual with specimens from the Canal Zone. A narrow foliaceous band is developed on each side of the escutcheon and another about the anterior extremity below the lunule. The Costa Rican examples are often very much larger than those of the Canal Zone, the concentric lamellæ are finer and less confluent and with more persistent radial lines. The following measurements will illustrate the range in size:

Length 30, heigth 23, thickness 15 mm, Central Zone.
37, 28, 19 " "
41.5, 32, 9.5 mm (right valve)
Old Man Sam Creek, C. R.
51.5, 38, 21.5 mm, Sousi, C. R.

Gatun Stage: Gatun, and Mt. Hope, C. Z.
Old Man Sam creek, C. R.
Sousi creek (Upper Hone creek)
Banana River.

Chione holocyma Brown and Pilsbry Plate 30, figure 9

Chione ulocyma Dall, variety *holocyma* Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. Phila., vol. 63, p. 369.

Associated with *mactropsis*, in the Central Zone is a more convex and finely sculptured shell, allied to the *ulocyma* Dall of of the Floridian Miocene. It is the *holocyma* of Brown and Pilsbry. We have seen no typical *ulocyma* from Panama.

From *mactropsis*, the *holocyma* will be distinguished by its generally smaller, more convex and more circular shell. Its concentric lamellæ are more numerous and less confluent and with fine but persistent radial striæ. It is generally best distinguished by its smaller and less clearly differentated foliaceous area on its anterior extremity, which in *mactropsis* is as wide an area as that along its posterior dorsal margin.

Heigth 29, length 36.5, thickness 19 mm.

Gatun Stage: Mt. Hope, C. Z.

Chione hotelensis, n. sp. Plate 32, figure 7

Shell small, subtrigonal, heavy, but slightly convex; sculpture of about 15, thick, rounded and evenly spaced concentric lamellæ; on the posterior-dorsal slope, the ends of the lamellæ become attenuated, thin and somewhat appressed as in *glyptocyma* Dall of the Flordian Miocene; the lamellæ themselves are smooth and rounded but with their interspaces finely radially incised by small lines; escutcheon rather large, smooth; lunule small, cordate and smooth except for the growth lines,

Length 23, height 19, thickness 12.5 mm.

This elegant little species is distantly related to the *C. glyptocyma* Dall from the Oak Grove sands of Florida, but is a smaller and more compact shell. The radial striations commence on the ventral surface of the lamellæ and are continued across the interspace to the base of the next rib.

All of our specimens were collected in a hard sandstone in the lower Gatun of Hotel Creek near Old Harbor, Costa Rica.

Uscari Stage: Hotel creek, C. R.

Chione chiriquiensis, n. sp. Plate 32, figure 9, 10

Shell small, solid, depressed; lunule rather large, cordate, smooth; escutcheon large, smooth and defined by an angled ridge; surface of the disk sculptured with about 8, large, irregular ribs, like those of *Chione latilirata*; these ribs do not extend to the edge of the escutcheon, but commence a short distance in front leaving a narrow band which is smooth and sculptureless; the ribs are of variable size, flat-topped and smooth; they are rounded on their ventral side, but shelving or recurved backwards on the dorsal face; interspaces smooth or only sculptured with fine growth-lines; interior of shell of moderate depth, with a small pallial sinus and with a slightly larger posterior adductor scar; basal margin finely crenulated.

Length 13.75, height 12.50, diameter 9.50 mm.

The few specimens which we have from Water Cay, are probably immature, but they possess such distinctive characters that the species cannot be mistaken.

The heavy, irregular concentric ribs recall certain varieties of *Chione latilirata* Conrad. They differ in being abruptly cut off or flattened a short distance behind the dorsal-posterior angle leaving a band as in *C. paphia* Linnæus, but smooth and sculptureless. The interspaces are smooth.

Gatun Stage: Water Cay.

Section **TIMOCLEA.** Brown

Chione grus Holmes, var. Plate 26, figure 21

Tapes grus Holmes, 1858, Post-Pliocene Fossils of S. Car., p. 37, pl. 7 fig. 5.

Chione (Timoclea) grus Dall, 1903, Trans. Wagner Free Inst. Sci., vol. 3, pt. 6, p. 1299.

We have but a single and not entirely perfect specimen of a *Timoclea* closely related to *C. grus* Holmes. It is somewhat more convex than typical *C. grus* from the Carolinas and more finely sculptured. More material is needed to show whether or not these charaters are constant. The *C. grus* appears as a fossil in the Upper Chesapeake Miocene of the eastern United States and is recent from Cape Hatteras to Yucatan.

Gatun Stage: Coll. 4, Red Cliff creek.

Genus **TELLINA**, (Linné) Lamarck

Tellina rovala, n. sp. Plate 26, figures 7, 8

Shell elongate, slender, subequilateral with the beaks situated near the center of the shell; anterior side long, with a straight dorsal margin and narrowly rounded at its extremity; posterior side much narrowed and rostrate, the left valve with 2 radial bands forming the rostrum, the dorsal one a fold, the other a wide sinus; ventral margin rounded anteriorly, nearly straight about the middle and a wide sinus posteriorly; the surface is sculptured with even, concentric lamellæ; this sculpture on the rostrum is heavier and on crossing the fold and sinus become reversed in position.

Length	height	semi-diameter
29,	12,	2.5 mm.
36 ?	14	3 mm.

We have two specimens of this typical *Tellina* from Water Cay. The larger specimen is fragmentary but probably measured when complete about 36 mm in length. The species recalls the recent West Indian *T. interrupta* Wood (*T. antonii* Philippi) in its form and sculpture but lacks the finer radiating striæ.

Gatun Stage: Water Cay.

Subgenus **ARCOPAGIA**, (Teach)

Section **MERISCA**, Dall

Tellina crystallina Wood Plate 26, figure 10

Tellina crystallina Wood, 1815, General Conchology.

Tellina (*Merisca*) *crystallina* Dall, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 311, pl. 2, fig. 10.

Tellina (*Merisca*) *crystallina* Maury, 1917, Bull. Amer. Pal., vol. 5, p. 387, pl. 38, fig. 4.

This *Tellina*, the type of the section *Merisca*, is recognized by its thin, depressed shell, strongly sculptured with distant, but regular, raised, concentric lamellæ. It is very rare as a fossil, our collection containing but a single specimen from the Gatun beds of the Banana River. It has previously been recorded by Maury as a Miocene fossil in Santo Domingo.

In the recent fauna, *Tellina crystallina* is distributed along both the Atlantic and Pacific coasts of Central America. I have collected a few specimens from the beaches of Bocas Island and more abundantly at Bucaru, Province of Los Santos, on the Pacific side of Panama.

Gatun Stage: Hill No. 2. Banana River.

Tellina nasua, n. sp. Plate 26, figure 17

Shell sub-rhomboid, slightly convex, thin; beaks small, inconspicuous, posterior to the middle; the anterior end longer, the dorsal-anterior dorsal margin descending, the extremity rounded into the gentle curve of the base; (the posterior side broken in the type specimen); the greatest convexity of the shell lies along the broad, umbonal slope anterior to the beaks; the surface is finely sculptured with regular, sharp, concentric ridges, separated by narrow, band-like interspaces; interior of the right valve with a large pallial sinus which extends to the anterior ¼ of the shell; hinge appearing normal for the section, but partly broken away, but showing a large anterior lateral tooth.

Length 20? Height 15.25, diameter of the right valve 3.00 mm.

Our specimen if fragmentary, the posterior portion of the shell being broken away. There is however little doubt that the species is a true *Merisca*, allied to *T. æquistriata* Say and

T. lintea Conrad. It differs from *æquistriata* in its greater dorsal anterior slope and finer sculpture, and from *T. lintea* of the recent fauna, in its somewhat greater proportional height and greater convexity.

Gatun Stage: Coll. 4, Red Cliff creek.

Section **PHYLLODINA**, Dall

Tellina lepidota Dall Plate 26, figures 4, 5

Tellina (*Phyllodina*) *lepidota* Dall, 1900, Trans. Wagner Free Inst. Sci., vol. 3, pt. 5, p. 1022, pl. 46, fig. 18.

Dall's type of this species is based on a fragmentary right valve from Gatun. We have several complete and large specimens from Water Cay, where the species is fairly common. The right valve is flat and depressed, the left more convex. Both valves are nearly similarly sculptured with 2 or 3 wide undulations of the beaks, which are soon replaced by even, sharp, concentric lamellæ, of which 3 or 4 are higher and more lamellose on the dorsal margin.

Length 24, height 12.5, diameter of the left valve 2.75 mm.

Length 21.5, height 11.00, diameter of the right valve 1.25 mm.

Gatun Stage: Water Cay.

Section **EURYTELLINA**, Fischer

Tellina costaricana, n. sp. Plate 26, figures 6, 9

Shell oblong, depressed; beaks small and inconspicuous about the middle of the shell so that the anterior and posterior ends are of nearly the same length; posterior end widely rounded the anterior but slightly narrowed and less rounded at its extremity; anterior and posterior dorsal margins nearly straight; surface of the disk finely sculptured with even, concentric lines which are slightly lamellose on the posterior-dorsal margin; interior concealed.

Length 32, height 19, semi-diameter 2 mm.

This species is related to the recent West Indian *T. angulosa* Gmelin and its Pacific analogue, the *T. rubescens* Hanley. The fossil shell differs by its more central beaks and sharper concentric sculpture, which is continued across the entire surface of the disk.

Gatun Stage: Hill No. 3, Banana River.

Tellina dariena Conrad Plate 26, figure 3

Tellina dariena Conrad, 1857, Pacific R. R. Reports, vol. 5, p. 328, pl. 6, fig. 53.

Tellina semilævis Gabb, 1861, Proc. Acad. Nat. Sci. Phila., vol. 12, p. 567.

Tellina Dariena Gabb, 1881, Journ. Acad. Nat. Sci. Phila., vol. 8, p. 343, pl. 44 fig. 13.

Tellina Rowlandi Toula, 1908, Jahrb. der K-K. Geol. Reichsanstalt vol. 58, p. 728, pl. 28, fig. 11.

Tellina Rowlandi Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. Phila., vol. 63, p. 368.

Conrad's figure of *Tellina dariena* is very poor but probably represents this species, the most abundant *Tellina* at Gatun. Conrad's figure shows a subtrigonal shell, with a produced and truncated posterior extremity. In 1861, Gabb described *Tellina semilævis* together with *Arca chiriquiensis* from the Gatun beds of the Chiriqui Lagoon. This species Gabb however later considered synonymous with the earlier *Tellina dariena* of Conrad. Toula's *Tellina Rowlandi* is certainly identical with Gabb's *Tellina semilævis* as figured by Gabb.

Shell but slightly convex, subequilateral with the beaks situated a short distance posterior to the middle of the shell; anterior and posterior dorsal slopes straight and evenly descending; posterior end rounded and subtruncate, the anterior rounded; beaks low; surface striated with very fine concentric lines and the shell may sometimes appear nearly smooth and polished especially on the umbonal areas; hinge of the left valve with a bifid anterior cardinal, a small posterior and 2 laterals; the anterior adductor is bordered on the posterior side by a thickened internal ray; pallial sinus long, ascending above in the middle of the shell and touching the anterior adductor scar.

Length 34, height 19.5, semi-diameter 3.50 mm.

Gatun Stage: Gatun, C. Z.
Water Cay.
Chiriqui Lagoon and Oronli creek (*Gabb*)

Subgenus **ANGULUS,** Mergerle

Section **ANGULUS**, s. s.

Tellina umbra Dall — Plate 26 figures 12, 15

Tellina (*Angulus*) *umbra* Dall, 1900, Trans. Wagner Free Inst. Sci., vol. 3, pt. 5, p. 1033, pl. 46, fig. 13.

The Costa Rican specimen consists of a small individual with both valves. It is somewhat smaller than typical *umbra*, from the Upper Chesapeake Miocene of the Carolinas, but agrees in form and in the fine surfrce sculpturing.

The *Tellina umbra* is a common fossil in the Upper Chesapeake Miocene of the eastern United States and in the Pliocene of Florida. It is closely allied to the recent *Tellina sybaritica* Dall of the West Indies, differing most importantly in its less angular posterior extremity.

The Costa Rica specimens measures:

Length 8.00, height 4.15, diameter 2.25 mm.

Gatun Stage: Coll. 4, East Grape Point creek.

Section **SCISSULA,** Dall

Tellina cercadica Maury

Tellina (*Scissula*) *cercadica* Maury, 1917, Bull. Amer. Pal., vol. 5, p. 388, pl. 38, fig. 9.

The Costa Rican specimens are fragmentary but there can be little doubt of their identity with the *Tellina cercadica* Maury from the Miocene of Santo Domingo.

The shell is thin and strongly depressed. The surface is polished and obliquely striated with fine lines. It is related to the recent Pacific *Tellina delicatula* Deshayes.

Gatun Stage: Coll. G, Saury creek.
Estrella River.

Genus **TELLIDORA**, Moerch

Tellidora cristata Recluz Plate 26, figurce 1, 2

Lucina cristata Recluz, 1742, Revue Cuvier., p. 270.

Tellidora cristata Dall, 1900, Trans. Wagner Free Inst. Sci., vol. 3, pt. 4, p. 1037.

A recent species of the West Indies and previously known as a Pliocene and Pleistocene fossil from Carolinas. The fossil Costa Rican shells are frequently larger than the recent form and with the dorsal margins more nearly in line. It is not rare in the form of impressions but the perfect shell is seldom found.

Gatun Stage: Hills 1a, 2 and 3, Banana River.

Genus **STRIGILLA**, Turton

Strigilla pisiformis Linné

Tellina pisiformis Linné, 1758, Syst. Nat., ed. 10, p. 677.

Strigilla pisiformis Dall, 1900, Trans. Wagner Free Inst. Sci., vol, 3, pt. 5, p. 1038.

Strigilla pisiformis Maury, 1917, Bull. Amer. Pal., vol. 5, p. 389, pl. 39, fig. 6.

This species is rare as a fossil in Costa Rica. It is very common as a recent shell on the sandy beaches along the entire north coast of both Panama and Costa Rica, where it occurs with *Donax denticulata* Linné and a few other species. It is also found as a Miocene fossil in the Bowden beds of Jamaica and in Santo Domingo.

Gatun Stage: Middle creek.

Strigilla musanica, n. sp. Plate 26, figure 18

Shell subtrigonal, moderately convex, subequilateral; the umbos are broad and wide, situated about the middle of the shell, with the greatest convexity of the shell lying along the anterior-umbonal slope; the anterior end is broad and rounded, the posterior slightly narrow, but not produced; the sculpture is divided between three areas, the posterior, central and anterior, each of which is set off from the adjacent one, by a marked change in sculpture along a well-defined line; on the anterior area, it consists of a concentric series of wave-like incised lines, the crest of the wave lying near the posterior side and directed as usual dorsally; on the central area, the lines are vertically directed, commencing on the lines bordering the posterior side; on the posterior area, the lines commence on the anterior side and pass vertically, forming therefore with the middle lines very acute angles; the interior is concealed in our specimen.

Length 13.00, height 11.50, diameter of the right valve 3.00 mm.

Differs from *Strigilla carnaria* Linné of the recent West Indian fauna, by being more inequilateral, more convex and in details of its sculpture which is sharply divided between three areas as described. The interior of the type specimen is concealed, so that the features of the pallial line and sinus cannot be determined.

Gatun Stage: Hill No. 3, Banana River.

Genus **METIS**, H. and A. Adams

Metis barba, n. sp. Plate 29, figures 3, 4

Shell subquadrate, inequilateral, with the beaks situated at the anterior two-thirds of the total length of the shell; anterior end longer with a sloping dorsal margin and rounded anterior extremity; posterior side shorter, with a dorsal margin sloping more rapiding to the wide and flexed posterior end; the left valve is convex but depressed along the narrow posterior submargin or wing; the right valve is less convex with a broad depressed area extending from the beaks to the ventral margin; this depressed zone is sharply separated from the posterior-dorsal slope or wing by a strong angle or flexure which corresponds to the sinus in the middle of the wing on the left valve; surface finely striated with concentric growth-lines.

Length 48, height 37, diameter 19 mm.

Pilsbry and Johnson have described without figuring, two species of *Metis* from the Miocene of Santo Domingo (the *M. efferta* and *postrema*). These species, they compare with the *M. chipolana* Dall, from the Chipola beds of Florida and mention in their description the nearly central location of the beaks. In the Costa Rican shell the beaks are at the posterior one-third of the shell. It is very distinct from the *M. chipolana* Dall. *M. trinitaria* Dall from Trinidad and Porto Rico differs in its more central beaks, fuller umbos and has the right valve much less flexed posteriorly.

Gatun Stage: Betey creek.

Genus **MACOMA**, Leach

Macoma costaricana, n. sp. Plate 26, figures 14, 16

Shell broadly ovate, thin and slightly inflated; dorsal and ventral margin straight and parallel; the posterior dorsal side sloping to the rounded ventral extremity; anterior extremity rounded; the posterior side is very slightly flexed; surface smooth except for very fine, incremental growth lines; interior of shell concealed.

Length 29, height 19, semi-diameter 4.5 mm.

The reference of this species is *Macoma* is doubtful as the hinge is completely concealed in all our specimens. It has the form of the *M. Conradi* Dall, from the Chesapeake Miocene of United States but is higher and differs in many other respects. It is shorter and higher than *M. gatunensis* Toula with which it may occur.

Gatun Stage; Hill No. 3, Banana River.
Rio Betey.

Subgenus **PSAMMACOMA,** Dall

Macoma gatunensis Toula Plate 26, figure 13

Macoma (*Tellina*) *gatunensis* Toula, 1908, Jahrb. der K-K Geol. Reichsanstalt, vol. 58, p. 729, textfigure 10.

Tellina gatunensis Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. Phila., vol. 63, p. 368.

This shell is extremely similiar to the recent *M. elongata* Hanley of the Pacific coast of Panama and I have failed to find any character which will distinguish the fossil shells from the recent ones. Our shells were all collected loose near Hill 3, of the Banana River and were probably derived from beds low in the Gatun formation.

Gatun Stage: loose, near Hill 3, Banana River (*Terry*).

Macoma panamensis Dall, var. **canalis,** n. var, Plate 26, figure 11

Cf. *Macoma* (*Psammacoma*) *panamensis* Dall, 1900, Proc. U. S. Nat. Mus., vol. 23, p. 324, pl. 4, fig. 3.

The *Macoma panamensis* Dall was described from a left valve dredged from 33 fathoms of water in Panama Bay. The fossil shell, also a left valve from the Gatun of Mt. Hope, differs most importantly from Dall's figure in being somewhat higher. The shell is thin and extremely fragile, with the surface simply scultured with the fine growth lines. The interior is concealed so that the characters of the pallial sinus cannot be seen. The specimens measures as follows:

Length 30.50, height 15.00, diameter of the left valve 3.00 mm.

Gatun Stage: Mt. Hope, C. Z.

Genus **SEMELE**, Schumacher

Semele lævis Sowerby, var. **costaricensis**, n. var. Plate 29 figure 1

Cf. *Amphidesma lævis* Sowerby, in Reeves, 1853, Conch. Icon., pl. 7, fig. 50.

Shell large, subelliptical, but slightly convex; beaks very nearly central, the posterior side wide and well rounded, the anterior somewhat narrowed, contracted and slightly the longer; the surface is nearly smooth and porcellaneous, faintly marked on the anterior and posterior extremities by fine, concentric lines.

Length 72, height 65.50, semi-diameter 8 mm.

This large *Semele* is quite common in the Lower Gatun beds of the Banana River. It is closely related to the recent Pacific *S. lævis* Sowerby, but differs in being slightly longer and more evenly rounded at its posterior extremity.

Gatun Stage: Hill No. 3, Banana River.
Hill 1a, Banana River.

Semele Sayi Toula Plate 29, figure 8

Semele Sayi Toula, 1908, Jahrb. der K-K Geol. Reichsanstalt, Wien, vol. 58, p. 730, pl. 28, fig. 17.

Semele Sayi Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. Phila. vol. 63, p. 368.

Shell convex, rather thin, with the umbos nearly central. The anterior side is somewhat narrow or contracted, and rounded at its extremity. The surface is sculptured with fine, hair-like, concentric threads. The species was described by Toula from the Canal Zone. Our record from Costa Rica is based on a single, imperfect specimen from Sousi creek, where it occurs associated with *Clementia*, *Chione mactropsis* and *Turritella altilira* variety *costaricensis* in the lower part of the Gatun formation.

Gatun Stage: Sousi creek.

Semele Claytoni Maury Plate 29, figure 2

Semele Claytoni, Maury, 1917, Bull. Amer. Pal., vol. 5, p. 227, pl. 35, fig. 9.

The *S. Claytoni* was described by Dr. Maury from the Cercado formation, Santo Domingo of Lower Miocene age. It is a large species, reaching a length of 66 mm or more and characteristically sculptured with even, concentric lamellæ like the related species from the Tertiaries of eastern United States as *chipolana* Dall, *Leana* Dall and *perlamellosa* Heilprin. From these, the *S. Claytoni* is distinguished in having its radial striæ nearly obsolete. Our specimen from Costa Rica is fragmentary but probably measured when perfect 38 by 30 mm.

Uscari Stage: Hotel creek.

Genus **ABRA**, (Leach) Lamarck

Abra triangulata Dall Plate 29, figure 10

Abra triangulata Dall, 1900, Trans. Wagner Free Inst., Sci., vol. 3, pt. 5, p. 997, pl. 49, fig. 4.

A small, rotund or trigonal species abundant in the shale beds of Bocas Island. The valves are nearly equilateral, the anterior end slightly the larger and inflated. Surface smooth and shining. The type was described by Dall from the Bowden beds of Jamaica. Our specimens are a little larger, measuring:

Length 7.25, height 6.50, diameter of the left valve 1.75 mm.

Gatun Stage: Bocas del Toro.

Genus **PSAMMOSOLEN,** Risso

Psammosolen gatunensis Toula, var. **costaricensis,** n. var.

Plate 29, figure 7

Solecurtus gatunensis Toula, 1908, Jahrb. der K-K. Geol. Reichsanstalt, vol. 58, p. 732, pl. 28, fig. 12.

Solecurtus gatunensis Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. Phila., vol. 58, p. 372.

Shell rather large, elongate, convex, the dorsal and ventral margins straight and parallel; the low, inconspicuous beaks situated at the anterior ⅓, the anterior end rounded, the posterior subtruncate; two low, radial depressed rays extend from the beaks obliquely to the ventral margin; the central part of the shell and the anterior end is sculptured roughly with irregular growth lines; the posterior dorsal slope has strong, vertical or slightly oblique lines which cross the finer concentric growth lines; in addition the whole surface of the shell is roughened by small, short threads as if the surface had been painted with a stiff brush.

Length 63, height 25.50, diameter of the right valve 14.50 mm.

Toula's figure of an internal mold shows a smaller shell, a strong anterior-umbonal angle and a somewhat shorter anterior end. It is possible that the two forms are distinct but we lack a good comparative series of the Gatun shell. A smaller and more delicate species of *Psammosolen* occurs at several localities in the Costa Rican Gatun. It is not the *P. strigillatus* (*L*) of Toula, differing in its pointed anterior end.

Gatun Stage: Rio Betey.

Genus **SANGUINOLARIA,** Lamarck

Section **SAMMOTELLA,** Blainville

Sanguinolaria alouatta, n. sp. Plate 29, figures 5, 6

Shell rather large, elongate; and rostrated behind; left valve nearly flat, the right valve much more convex; the right valve carries a strong umbonal keel from the tip of the beaks to the posterior extremity; this keel is but poorly developed on the left valve; anterior end broadly rounded with the dorsal and ventral margins nearly parallel; the posterior side is much narrower and with its extremity pointed; the surface is smooth; the dorsal-posterior slope of the left valve is less smooth and carries coarse, irregular growth-lines; the interior is not known.

Length 54, height 30, semi-diameter 4 mm (a left valve)
Length 60, height 27.5 semi-diameter 7 mm (a right valve)

This species stands intermediate between the *S. Smithwoodwardi* Maury from the Miocene of Santo Domingo and the recent West Indian *S. operculata* Gmelin. It differs from the *Smithwoodwardi*, in being much larger with a less depressed left valve: From *operculata* the Costa Rican shell has higher and more pointed beaks as well as being longer posteriorly. In full-grown specimens of *operculata*, the surface generally shows radial lines and striæ which may become quite strong near the posterior ventral margin. The Costa Rican shells are smooth except for the growth lines.

Gatun Stage: Hill No. 3, Banana River.

Genus **TAGELUS**, Gray

Tagelus cebus, n. sp. Plate 29, figure 9

Shell elongate, moderately convex and solid; beaks central with the anterior and posterior ends nearly equal, and with the dorsal and ventral margins parallel and nearly straight; anterior and posterior extremities subtruncate; a broad depressed zone extends from the umbos to the ventral margin of the valves; surface marked with irregular concentric lines of growth; interior concealed.

Length 36, height 13, diameter of the left valve 3.00 mm.

The *Siliqua subæqualis* Gabb, from the Miocene of Santo Domingo is doubtless a *Tagelus*, belonging to the Section *Mesopleura* Conrad. It differs from the present shell in being thinner, more depressed and more pointed posteriorly. Gabb's species approaches very closely the recent *T. divisus* Spengler of the West Indian fauna, judging from the specimens in the Maury collection at Cornell, differing mainly in its larger size.

The interior of the Costa Rican shell is concealed so that the presence or absence of an internal rib cannot be determined. Its heavier shell and general form, is more that of typical *Tagelus* differing from the recent *gibbus* Spengler in its more central beaks.

Gatun Stage: Rio Betey.

Genus **MACTRA** (L.) Lamarck

Subgenus **MACTRELLA**, Gray

Mactra exoleta Gray Plate 28, figure 2

Mactra exoleta Gray, 1837, Mag. Nat. Hist., p. 372.
Mactra exoleta Reeve, 1854, Conch. Icon., *Mactra*, fig. 16.

Comparision of our fragmentary shell with recent examples from the Bay of Panama show no inportant differences. The species is notable for its high, narrow, inflated umbos, strongly depressed posterior-dorsal margin and alation of its dorsal-posterior angle.

At the present time, this species is restricted to the Pacific side, but represented on the Caribbean coast by the next, the *Mactra alata* Spengler, common along sandy beaches. It is therefore of more than usual interest to find these two species, together in the Miocene beds of the Caribbean slope of Costa Rica.

Gatun Stage: Boucary creek.

Mactra alata Spengler Plate 28, figure 3

Mactra alata Spengler, 1802, Skriv. Naturch. Selsk., vol. 5, part 2, p. 99.

Mactra alata Reeve, 1854, Conch. Icon., *Mactra* pl. 8, fig. 29.

Mactra (*Mactrella*) cf. *alata* Maury, 1917, Bull. Amer. Pal., vol. 5, p. 395.

A thin, fragile species distinguished by its sharp dorsal-posterior angle and hatchet-shaped shell. It is related to the *exoleta*, already referred to, but is a very much broader shell. In *exoleta*, the dorsal-posterior area is flat or concave, with a slight raised line which is bounded on each side by a markly depressed or sunken band. In *alata* this area is convex.

It is living today on the Caribbean side of the Isthmus, being quite common on sandy beaches.

Gatun Stage: Boucary Creek.
Hill No. 3, Banana River.

Section **HARVELLA**, Gray

Mactra estrellana, n. sp. Plate 28, figure 1

Shell rather large, ovate, thin, slightly convex; surface regularly, concentrically plicated; the fragmentary type specimen about 38 mm in height has about 32 plicæ which on the center of the shell disk are spaced about 2 mm apart; these plicæ commence as in typical *Harvella* at the dorsal-posterior carina which bounds the escutcheon and extends across the surface to the anterior extremity; the surface is, in addition, finely, concentrically striated; lunule large elliptical, smooth or finely striated; escutcheon smooth; interior not known.

Length 50, height 38, semi-diameter 8 mm,

Although this is not a very rare species in the Costa Rican Miocene, its thin, delicate shell renders the collecting of good specimens very difficult and it is usually secured only as distorted internals molds. It is related to the recent Pacific *H. elegans* Sowerby, but differs in being less convex, wider and with more numerous and closer concentric plicæ.

Gatun Stage; Coll. 6. Estrella River.
Coll. 2, Quitana creek.

Mactra sincola, n. sp. Plate 28, figure 4

Shell thin, broadly subtrigonal, depressed, nearly equilateral; beaks small and pointed anteriorly; lunule absent; escutcheon linear-lanceolate and defined from the shell disk by an elevated carina; the surface is sculptured with strong, wave-like, concentric plicæ which are continuous from the anterior-dorsal margin to the edge of the escutcheon; on the type specimen there are about 30 plicæ on the center of the shell disk, spac ed about 1.75 mm apart; the intervals between the concentric plicæ are deep and trough-like and in width equal to the plicæ themselves; in addition the whole surface of the shell is finely sculptured with small, radial, vermiculate threads, best seen on the summits of the plicæ; the escutcheon is ridged on the middle and smooth; the hinge, largely concealed in the sandy matrix, is mactroid.

Length 36, height 27, diameter of the right valve 5.5 mm.

The systematic position of this interesting shell is very doubtful. Its general surface sculpture of strong, concentric plicæ and well-defined escutcheon resembles that of *Harvella*. The surface is covered with fine, vermiculate threads as seen on *Labiosa*.

Gatun Stage: Saury creek.

Genus **LABIOSA**, (Schmidt) Moller

Labiosa lineata Say Plate 21, figure 11

Lutraria lineata Say, 1821, Journ. Acad. Nat. Sci. Phila., vol. 2, p. 310.

Mactra Nuttallii Reeve, 1854, Conch., Icon., *Mactra*, fig. 125.

Labiosa lineata Dall, 1898, Trans. Wagner Free Inst. Sci., vol. 3, pt. 4, p. 906.

This species is represented in our collection by fragments of the hinge and a perfect mold of the interior which is figured. This mold compares very closely with recent specimens of *Labiosa lineata* Say.

Dall records this species as fossil in the Pliocene Caloosahatchie beds of Florida and we have several fragments in the Cornell collection from the Upper Chesapeake Miocene of Natural Well, North Carolina.

Gatun Stage: Saury creek.
Coll. 6, Estrella River.

Genus **MULINIA**, Gray

Mulinia lateralis Say, var. **sauryensis**, n. var. Plate 28, figures 23. 24

The species of *Mulinia* are extremlly variable and we have therefore associated this form with the common *lateralis* of Say, although it may later prove to be a distinct species.

The general form of the shell is like *corbuloides* Deshayes, the common Gulf variety of *lateralis* of Say. It differs most importantly from *lateralis* in having the beaks situated a short distance above the hinge-line as is seen in the Chesapeake Miocene *M. congesta* Conrad. In other characters, the Costa Rican shells are more closely related to the *lateralis*, than to the *congesta*. The shell is fairly convex and thin.

Length 20, height 16, semi-diameter 6 mm.

Gatun Stage: Zone E, Saury creek.

Genus **MESODESMA**, Deshayes

Mesodesma costaricensis, n. sp. Plate 28, figure 18

Shell ovate, moderately convex, inequilateral, thin; anterior end about ½ again as long as the posterior, rounded; beaks high, triangular; posterior and anterior dorsal margins straight; ventral margin evenly rounded; surface nearly smooth; but with the dorsal submargins finely concentrically grooved; interior concealed.

Length 22, height 16, semi-diameter 4 mm.

A rather thin, *Donax*-like shell from the Lower Gatun beds of the Banana River. Its surface is smooth and polished with concentric grooves on its posterior and anterior dorsal area.

Gatun Stage: Hill No. 3, Banana River.

Genus **GASTROCHAENA**, (Spengler) Cuvier

Gastrochæna rotunda Dall

Gastrochæna ovata Sowerby, variety *rotunda* Dall, 1898, Trans. Wagner Free Inst. Sci., vol. 3, pt. 4, p. 825.

Gastrochæna rotunda Dall, 1915, Bull. N. S. Nat. Mus., No. 90, p. 157, pl. 19, fig. 2.

A single, small specimen of a *Gastrochæna* was collected in the Gatun of Red Cliff Creek. It is widely expanded about the posterior portion and probably represents a young shell of *G. rotunda* which Dall records from the Bowden beds of Jamaica. This species is also found in the Tampa Silex beds and in the Lower Miocene of Florida.

Gatun Stage: Coll. 4, Red Cliff Creek.

Genus **CORBULA**, Lamarck

Section **ALOIDIS**, Megerle

? Corbula vieta Guppy Plate 28, figures 15, 16

Corbula vieta Guppy, Quart. Journ. Geol. Soc. London, vol. 22, p. 580, pl. 26. fig. 8.

Corbula disparilis Gabb, 1873, Trans. Amer. Phil. Soc., vol. 15, p. 247.

Corbula (*Aloidis*) *vieta* Dall, 1898, Trans. Wagner Free Inst. Sci., vol. 3, pt. 4, p. 859.

Corbula (*Aloidis*) *vieta* Maury, 1917, Bull. Amer. Pal., vol. 5, p. 395, pl. 39, fig. 13.

The members of this group of *Corbulæ* are difficult to separate satisfactorily as all are quite similiar in their characters. The right valve is broad, high and coarsely sculptured with regular concentric costæ, while the left valve is much smaller, longer than high, with its surface smooth or faintly lined with unequally distributed radial threads.

The *C. vieta* was described by Guppy from the Manzanilla beds of Trinidad and most authors have regarded the *Erycina tensa* described at the same time as its left valve, an indentification which is open to question. Guppy's figure of *tensa*, shows a Veneroid shell strongly sculptured with even radials and fine concentric lines, and quite unlike the left valves of *Corbulæ* of the *Aloidis* section.

? *Corbula vieta* from Costa Rica is identical with Maury's specimens from the Miocene of Santo Domingo. It is a smaller and more circular shell than the *Corbula heterogenea* Guppy which we have from the Canal Zone.

Length 6.25, height 6.50, semi-diameter 3 mm. (right valve)

Gatun Stage: Water Cay.
Hill 1a, 3, Banana River.

Section **CUNEOCORBULA**, Cossman

Corbula oropendula, n. sp. Plate 28, figures 12, 13, 14, 26, 27

Shell small, solid, elongate, both valves of nearly equal convexity but the the right valve somewhat larger and overlapping on the left; beaks nearly central, the anterior end well rounded, the posterior somewhat contracted, slightly rostrated and with a well-marked keel; ventral margin more or less rounded, terminating at is posterior end in a small sinus, just anterior to the keel; the basal margins of both valves are folded in and flattened as seen in *C. contracta* Say but to a less extent and least in the right valve; surface sculpture of rather heavy concentric costæ, most widely spaced on the umbos; the surface may also show fine radial lines of small pustules or punctæ which are best developed on the rostrum; no lunular pit.

Length 6.5, height 4.25, diameter 4 mm (Banana River).
9 6 semidiameter 2 mm (Saury).

We have chosen as the type of this spceies, the smaller and more abundant form as found in the Gatun bed of the Banana River, rather than the larger shells from the more inaccessible Saury. It is related to the *C. contracta* Say, but differs in having the ventral margin more curved, and the posterior extremity more emarginate. Its surface is sculptured with rather strong, concentric costæ which are more widely spaced on the umbos, and submicroscopic radial lines of fine punctæ or small pustules, best seen on the rostral areas.

Gatun Stage: Hills 1a, 3, Banana river (abundant).
Zone G, Saury creek.
Coll. 6, Red Cliff creek.

Corbula Dietziana C. B. Adams Plate 21, figure 8

Corbula Dietziana C. B. Adams, Contr. Conch., vol. 12, p. 235.

Corbula (*Cuneocorbula*) *Dietziana* Dall, 1898, Trans. Wagner Free Inst. Sci., vol, 3, pt. 4, p. 856.

A recent species quite common in the coralline limestones of the Limon Peninsula, from which it has previously been reported by Dall from specimens collected by Hill.

In its earlier stages of growth, this species resembles the *C. æquivalvis* Phil. (*C. cubaniana* d'Orb) in its rectangular from and strong dorsal keel. Later in life, the shells become strongly distorted, the ventral margin is abruptly bent downwards nearly at right angles to the former plane of the shell as is seen to a much less degree in the recent *C. contracta* Say. Its surface is coarsely concentrically grooved, the two valves being sculptured alike.

Gatun Stage: Port Limon.

Corbula hexacyma Brown and Pilsbry Plate 21, figures 12, 13

Corbula hexacyma Brown and Pilsbry, 1912, Proc. Acad. Nat. Sci. Phila., vol. 64, p. 518, pl. 26, fig. 4.

A species of the Gatun beds of the Central Zone. The shell is rather large, solid and with its valves similiary sculptured with a few, deep, wave-like, concentric ribs. Its right valve is slightly more convex than its left. Our specimens measure:

Length 20, height 14, diameter of the left valve 6.00 mm.

Length 20, height 13.50, diameter of the rigth valve 5.75 mm.

Gatun Stage: Gatun, C. Z.

Corbula orosi, n. sp. Plate 21, figures 9, 10

Shell elongate, convex with the low inconspicuous beaks about the middle of the shell, so that the posterior and anterior ends of the shell are about equal in length; the right valve is slightly larger and its basal margin folds over slightly that of the left valve; anterior end rounded, the posterior narrow and more pointed but with the keel only very poorly developed; the surface is finely and evenly concentrically ribbed and both valves are similiarly sculptured; no lunule.

Length 20, height 11.5, diameter of both valves 9.5 mm.

A rather large species with nearly equally convex valves; surface sculptured with fine, regular, concentric ribs. It resembles the *C. sarda* Dall, from the Chipola Miocene but is much larger.

Gatun Stage; Hill No. 3, Banana River.

Section **BOTHROCORBULA,** Gabb

Corbula viminea Guppy Plate 28, figure 25

Corbula viminea Guppy, 1866, Quart. Journ. Geol. Soc. London, vol. 22, p. 293, pl. 28, fig. 11.

Bothrocorbula viminea Gabb, 1873, Trans. Amer. Phil. Soc., vol. 15 p. 247.

Corbula (*Bothrocorbula*) *viminea* Dall, 1898, Trans. Wagner Free Inst. Sci., vol. 3, pt. 4, p. 850.

Corbula (*Bothrocorbula*) *viminea* Maury, 1917, Bull. Amer. Pal., vol. 5, p. 397, pl. 39, figs. 20, 21.

This is a very characteristic species, distinguished by its large, deep lunule and its surface strongly sculptured with coarse, concentric, wave-like costæ. It is known from the Miocene of Jamaica and Santo Domingo.

The *Corbula hexacyma* Brown and Pilsbry, still known only from the Gatun of the Canal Zone is similiar in form and sculpture but lacks the deep lunular pit.

Length 15, height 10, semi-diameter 4.85 mm (right valve).

Gatun Stage: Middle creek.

EXPLANATION OF PLATES

PLATE I (4)

		Page
Fig. 1.	Terebra bipartita Sowerby, Saury Creek, height 77 mm	35
2.	Terebra dipartita Sowerby, Middle Creek, height 53 mm.	
3.	Terebra cf. haitensis Dall, Sousi Creek, height 37 mm	35
4.	Terebra gatunensis Toula var., Gatun, height 58 mm	36
5.	Terebra gatunensis Toula, Gatun, height 52 mm.	
6.	Terebra gatunensis Toula, Gatun, height 42 mm.	
7.	Terebra spirifera Dall, var. midiensis, n. var., Middle Creek	39
8.	Terebra gausapata Brown and Pilsbry, Mt. Hope, height 34 mm	38
9.	Terebra estrellana, n. sp. Estrella River, height 7.5 mm	40
10.	Terebra gausapata Brown and Pilsbry, Mt. Hope, height 29 mm	38
11.	Terebra Wolfgangi Toula, Mt. Hope, height 38 mm	37
12.	Terebra Wolfgangi Toula, Mt. Hope, height 26 mm.	
13.	Terebra spirifera Dall, Banana River	37
14.	Conus gracilissimus Guppy, Bocas del Toro	52
15.	Conus tortuosostriatus Toula, Bocas del Toro	49
16.	Terebra estrellana, n. sp., Estrella River	40
17-18.	Terebra Berlineræ Maury, Boucary Creek..	39
19.	Terebra costaricensis, n. sp., Banana River, height 13 mm	40
20.	Conus marginatus Sowerby, Red Cliff Creek	51
21.	Conus multistriatus Bose, Water Cay	54
22.	Conus musæensis, n. sp., Banana River	47
23.	Conus multistriatus Bose, Water Cay	54
24.	Conus musæensis, n. sp., Banana River	47
25-26.	Terebra benthalis Dall, var. bocasensis, n. var., Bocas del Toro	41
27.	Terebra pumbriensis, n. sp., Pumbri Creek	41

PLATE 2 (5)

Page

Fig. 1-2. Conus molis Brown and Pilsbry, Banana River........... 42
3-4. Conus proteus Hwass, Water Cay................................ 43
5. Conus Veatchi, n. sp., Water Cay..... 44
6. Conus imitator Brown and Pilsbry, Mt. Hope....... 45
7. Conus toroensis, n. sp., Toro Cays...................................... 48
8. Conus Veatchi, n. sp., Water Cay.. 44
9. Conus recognitus Guppy, Banana River 46

PLATE 3. (6)

Fig. 1. Conus Harrisi, n. sp., Banana River..... 53
2. Conus stenostomus Sowerby, Port Limon....... 42
3. Conus floridanus Gabb, var. costaricensis, n. var Banana R... 45
4-5. Conus Burckhardii Bose, Water Cay.................................. 52
6. Conus tortuosopunctatus Toula, Mt. Hope........................... 54
7-8. Conus limonensis, n. sp., Port Limon............................ 47
9. Conus floridanus Gabb, var. costaricensis, n. var., Banana R. 45
10. Conus planiliratus Sowerby, Port Limon.,.......................... 50
11. Conus tortuosopunctatus Toula, Mt. Hope.......................... 54
12. Conus cf. interstinctus Guppy, Banana River...................... 48
13. Conus planiliratus Sowerby, Port Limon............................. 50
14. Conus planiliratus, var. bocasensis, n. var., Bocas del Toro.. 57
15. Conus granozonatus Guppy, Rio Blanco.............. 50
16. Conus planiliratus var., bocasensis, n. var., Bocas del Toro.. 51

PLATE 4. (7)

Fig. 1-2. Turris albida Perry, slightly reduced, Toro Cays............ 58
3. Scobinella Morierei (Laville) Cossmann, length 48 mm, Toro Cays.............................. 79
4. Scobinella Morierei (Laville) Cossmann, length 52 mm., Toro Cays.............................. 79
5. Drillia papaya, n. sp., length 32 mm., Rio Cocles............... 63
6. Turricula lavinoides, n. sp., length 54 mm., Banana River.... 55
7. Halia americana, n. sp., length 66 mm., Mt. Hope.............. 79

			Page
Fig.	8.	Drillia consors Sowerby, Grape Point Creek, length 60 mm...	61
	9.	Drillia venusta Sowerby, Banana River, length 30 mm....	61
	10.	Drillia consors Sowerby, Mt. Hope, length 33 mm.........	61
	11.	Drillia carruca, n.sp., East Grape Point Creek, length 18 mm.	71
	12.	Turricula lavinoides, var. limonensis, n. var., length 97 mm., Toro Cays......	56
	13.	Drillia consors Sowerby, length 40 mm, Banana River.........	61
	14.	Bullaria paupercula Sowerby, Middle Creek, length 22 mm...	34c
	15.	Drillia limonica, n. sp., Port Limon, length 19 mm..............	66
	16.	Ancistrosyrinx Dalli, n. sp., Toro Cays, length 14 mm.........	60
	17.	Ancistrosyrinx elegans Dall, var., Banana R.,length 15 mm	60

PLATE 5. (8)

Fig.	1.	Drillia Cristobali, n. sp., Bocas del Toro, heigth 20 mm........	72
	2.	Drillia chirquiensis, n. sp., Bocas del Toro, height 25 mm..	64
	3.	Turricula taurina, n. sp., Bocas del Toro, height 25 mm........	57
	4.	Turricula Terryi, n. sp., Bocas del Toro, height 23.5 mm.....	57
	5.	Drillia bocasensis, n. sp., Bocas del Toro, height 22 mm.....	73
	6.	Drillia bocatoroensis, n. sp., Bocas del Toro, height 23 mm..	67
	7.	Drillia coccos, n. sp., Coco Plum, height 21 mm................	64
	8.	Drillia limonensis, n. sp., Port Limon, height 20 mm.........	71
	9.	Drillia limonensis, n. sp., height 15 mm.	
	10.	Drillia limonetta, n. sp., Port Limon, height 12.25 mm.........	70
	11.	Drillia theobroma, n. sp., Bocas del Toro, height 21 mm......	68
	12	Drillia citria, n. sp., Port Limon, height 11 mm.................	65
	13.	Drillia citria, n. sp., Port Limon, height 11 mm.	
	14.	Drillia cocosina, n. sp., Bocas del Toro, height 12 mm........	75
	15.	Drillia aurantia, n. sp., Port Limon, height 11 mm.....	68
	16.	Drillia aquanica, n. sp., Water Cay, height mm.................	65
	17.	Drillia aquanica var.	
	18.	Drillia lithocolletoides, n. sp., height 10.75 mm., Bocas del Toro..............................	74
	19.	Leucosyrinx chloris, n. sp., height 14.50 mm., Bocas del Toro..............................	69
	20.	Cytharella limata, n. sp., height 9 mm, Port Limon.............	77
	21.	Cythara terminula Dall, var. costaricensis n. var., height 13 mm., Hill 1a, Banana River......	77
	22.	Cythara terminula Dall, var. costaricensis n. var., height 13 mm., Hill 1a, Banana River.........	77
	23.	Borsonia cocoensis, n. sp., Coco Plum, height 16 mm...........	78

Page

Fig. 24. Borsonia cocoensis, n. sp., Coco Plum, 14 mm.................. 78
25. Drillia aquænsis, n. sp., Water Cay, height 15 mm.............. 73
26. Drillia musa, n. sp., Banana River, height 16 mm.............. 74
27-28. Drillia musacina, n. sp., Banana River, height 9 mm 69
29-30. Glyphostoma moinica, n. sp., Port Limon, height, 5.75 mm.................................. 76

PLATE 6 (9)

Fig. 1. Mitra Swainsoni Broderip, var. limonensis, n. sp., Port Limon, height 74 mm.. 100
2-3. Cancellaria Plummeri, n. sp., Toro Cays, height 34 mm... 85
4. Cancellaria toroensis, n. sp., Toro Cays, height 29 mm 84
5. Cancellaria Mauryæ, n. sp., Cercado de Mao, Santo Domingo. height 36 mm.................................... 82
6. Cancellaria Barretti Guppy, slightly enlarged, Banana River. 81
7. Cancellaria Rowelli Dall, East Grape Point Cr., height 30 mm. 84
8. Cancellaria dariena Toula, about natural size, Toro Cays........ 80
9. Cancellaria Cossmanni, n. sp., somewhat enlarged, Banana R. 81
10. Mitra longa Gabb, Gatun, height 40 mm.......................... 101
11. Cancellaria Cossmanni, n. sp., somewhat enlarged, Banana R 81
12. Cancellaria islacolonis Maury, enlarged, Red Cliff Creek........ 86
13. Mitra cf. rudis Gabb, Hone Walk Creek, height 33 mm.......... 102
14-15. Marginella MacDonaldi Dall, Banana R., height 28. mm... 95
16. Marginella mindiensis Cossmann, Gatun, height 9 mm.......... 96
17. Marginella MacDonaldi Dall, Banana R., height 26 mm......... 95
18. Mitra Almagrensis Toula, variety coralliophila, n. var., Port Limon, height 17 mm.......... 103
19. Marginella MacDonaldi Dall, Banana River, height 25 mm.... 95
20-21. Mitra poas, n. sp., about natural size, Port Limon................ 102
22. Marginella leander Brown and Pilsbry, enlarged, Gatun........ 98
23. Marginella mindiensis Crossmann, Gatun, height 17.5 mm...... 96
24. Mitra Almagrensis Toula, variety coralliophila, n. var., Port Limon, height about 17 mm......... 103
25. Mitra dariensis Brown and Pilsbry, Bocas del Toro, height 21 mm....................................... 101

PLATE 7. (10)

Fig. 1. Oliva cylindrica Sowerby, Old Man Sam Creek.................... 88
2-3. Oliva brevispira Gabb, Red Cliff Creek............. 88

			Page
Fig.	4.	Oliva brevispira Gabb, var. Giraudi Cossmann, Middle Creek.	88
	5.	Oliva gatunensis Toula, Gatun	89
	6-7.	Oliva Sayana Ravenel, var. immortua Pilsbry and Brown Banana River..	89
	8-9.	Oliva mancinella, n. sp., East Grape Point Creek	91
	10.	Ancillaria aquænsis, n. sp., Water Cay	94
	11	Olivella muticoides Gabb, East Grape Point Creek	92
	12-13.	Oliva testacea Lamarck, var. costaricensis, n. var., Banana River	90
	12.	Olivella muticoides Gabb, Red Cliff Creek	92
	15-16.	Olivella Boussaci Cossmann, var., Banana River	93
	17-18.	Olivella muticoides Gabb. Red Cliff Creek.	92
	19-20.	Olivella limonensis, n. sp,, Port Limon	93
	21.	Marginella avena Valenciennis, Banana River	97
	22.	Olivella Goliath, n. sp., Red Cliff Creek.	92
	23.	Olivella Goliath, n. sp., Banana River	
	24-25.	Olivella limonensis, var., bocasensis n. var., Bocas del Toro	94
	26-27.	Marginella collina, n. sp., Banana River.	97
	28.	Marginella avena Valenciennes, Port Limon	97

PLATE 8. (II)

Fig.	1.	Fasciolaria MacDonaldi, n. sp., Banana River, height 70 mm.	106
	2.	Voluta Alfaroi Dall, Banana River, height 63 mm	99
	3.	Solenosteira chiriquiensis, n. sp., Water Cay, reduced	114
	4.	Latirus taurus, n. sp., Toro Cay, slightly reduced	108
	5.	Fusus miocosmius, n. sp., Bocas del Toro, height 100 mm	103
	6.	Fusus honensis, n. sp., Hone Walk Creek, height 63 mm	104
	7.	Solenosteira Vaughani Dall, variety medioamericana, n. var. Toro Cays	113
	8.	Solensoteira Dalli Brown and Pilsbry, Gatun, slightly enlarged	113
	9.	Fasciolaria Gorgasiana Brown and Pilsbry, Rio Betey, height 39 mm	105
	10.	Latirus infundibulum Gmelin, Pumbri Creek, slightly reduced	107
	11.	Peristernia insula, n. sp., Water Cay, height 23 mm	110
	12.	Latirus irazu, n. sp., Port Limon, height slightly reduced	107
	13.	Peristernia tortugera, n. sp., Port Limon, height 29 mm	110

PLATE 9. (12)

		Page
Fig. 1.	Melongena consors Sowerby, Old Man Sam Creek, height 118 mm	112
2.	Phos Veatchi, n. sp., Hill 1a, Banana River, height 43 mm.	121
3.	Phos Veatchi, n. sp., Hill 1a, Banana River, height 41 mm.	121
4-5.	Phos gatunensis Toula, Gatun, height 30 mm	117
6.	Phos beteyensis, n. sp., Rio Betey, height 26 mm	122
7.	Northia northiæ Gray, variety miocenica, n.var., tip, Banana River	124
8-9.	Phos Moorei Guppy, variety costaricensis, n. var., Banana River, height 26 mm	118
10.	Phos mexicanus Bose, Water Cay, height 29 mm	117
11.	Phos mexicanus Bose, Water Cay, height 27.5 mm.	
12.	Phos elegans Guppy, variety limonensis, n. var., Port Limon length 27 mm	119
13.	Phos elegans Guppy, variety limonensis, n. var., Port Limon length 22.50 mm	
14.	Northia northiæ Gray, variety miocenica, n. var., Banana River	124
15.	Phos subsemicostata Brown and Pilsbry, Saury Creek, height 32 mm	121
16.	Phos metuloides Dall, Mt. Hope, height 19.5 mm	122
17.	Phos estrellensis, n. sp., Estrella River, height 19 mm	120
18.	Phos estrellensis, n. sp., Estrella River, height 16 mm.	
19.	Alectrion merenda, n. sp., Old Man Sam Creek, height 7 mm	124
20.	Alectrion ranuncula, n. sp., Banana River, height 14 mm	123
21.	Alectrion losquemadica Maury, Port Limon, height 11.50 mm	123
22.	Alectrion ranuncula, n. sp., Banana River, height 14 mm	123

PLATE 10 (13)

Fig. 1.	Marginella latissima, variety Pilsbryi, n. var., Banana R	96
2.	Marginella latissima, variety Pilisbryi, n. var., Gatun	
3-4.	Clava costaricana, n. sp., Banana River, height 40 mm	144
5.	Metula Harrisi, variety limonensis, n. var., Port Limon, heigh. 27 mm	116
6.	Metula Harrisi, variety limonensis, n. var., Port Limon, height 25 mm	116
7.	Strombina matima, n. sp., Banana River, height 12 mm	127

Page

8. Strombina costaricensis, n. sp., Middle Creek, height 15 mm 128
9. Strombina ambigua Guppy, Banana River, height 26 mm...... 126
10. Metula Harrisi, n. sp., Coco Plum, height 27 mm................ 116
11. Metula Gabbi Brown and Pilsbry, Mt. Hope, height 28.5 mm 115
12. Metula cancellata Gabb, Bocas del Toro, height 18.5 mm...... 115
13. Strombina Lessepiana Brown and Pilsbry, Gatun, height 25 mm.. 126
14. Strombina chiriquiensis, n. sp.. 130
15. Typhis alatus Sowerby, Toro Cays, height 23 mm................ 132
16-17. Strombina costaricensis, n. sp , Middle Creek.................. 128
18. Strombina cricamola, n. sp., Water Cay, height 16 mm......... 127
19. Strombina sincola, n. sp., Banana River, height 7 mm.......... 129
20. Strombina Lessepiana Brown and Pilsbry, Gatun................. 126
12. Strombina sincola, n. sp., Banana River, height 7 mm......... 129
22. Typhis linguliferus, variety costaricensis, n. var., Bannan R. 132
23. Sistrum nodulosum C. B. Adams, Red Cliff Creek............... 133
24. Strombina chiriquiensis, n. sp................. 130
25. Marginella musacina, n. sp., Banana River........ 98
26-27. Strombina costaricensis, variety musanica n. var. Banana R 129
28. Cerithium costaricensis, n. sp., Red Cliff Creek, height 28 mm.................................... 143
29. Typhis linguliferus, variety costaricensis, n. var., Banana R. 132
30. Clava alajuela, n sp., Middle Creek, height 17 mm............ 145
31-32. Drillia estrellana, n. sp., Estrella River, height 7.50 mm... 69
33-34. Columbella submercatoria, n. sp., Red Cliff Creek............. 125

PLATE 11 (14)

Fig. 1. Xancus scopulus, n. sp., Banana River, height 265 mm......... 111

PLATE 12 (15)

Fig. 1. Serpulorbis papulosa Guppy, Banana River.......................... 145
2. Malea elliptica Pilsbry and Johnson, Banana River, height 63 mm... 139
3. Sconsia lævigata Sowerby, variety Gabbi, n. var., Toro Cays, slightly enlarged....................... 136
4. Siliquaria modesta Dall, variety limonensis, n. var., Port Limon, somewhat enlarged......... 147
5. Siliquaria modesta Dall, variety limonensis, n. var., Port Limon, slightly enlarged............ 147

Page

6. Siliquaria modesta Dall, variety limonensis, n. var., Port Limon, slightly enlarged........... 147
7. Sconsia cocleana, n. sp., Rio Coles, height mm..................... 138
8. Cypræa cinerea Gmelin, Rio Blanco................................ 140
9. Cypræa almirantensis, n. sp., Water Cay, height 39 mm...... 140
10. Cypræa parisimina, n. sp., Port Limon, height 39 mm......... 139
11. Phalium moniliferum Guppy, Rio Betey, height 35 mm........ 135
12. Sconsia bocasensis, n. sp., Bocas del Toro, height 35 mm...... 137
13. Sconsia bocasensis, n. sp., Bocas del Toro.

PLATE 13. (16)

Fig. 1-2-3. Strombus pugiloides Guppy, Banana River...................... 142
4. Fasciolaria tulipa Linnæus, variety Port Limon.................. 105
5-6. Strombus gatunensis Toula, Water Cay, somewhat reduced.. 141
7. Polinices Stanislas-Meunieri Maury, Banana River, slightly reduced..................... 157
8. Natica Youngi Maury, variety cocleana, n. var., Cocles Creek, slightly enlarged............ 155
9. Natica canrena Linnæus, Gatun............................. 155
10-11-12. Architectonica granulata Lamarck, Banana River......... 154
13-14-15. Natica Guppyana Toula, Banana River.................. 156
16-17. Polinices subclausa Sowerby, Banana River...................... 157

PLATE 14. (17)

Fig. 1. Turritella oreodoxa, n. sp., Banana River, height 49 mm.. 152
2. Turritella exoleta Linnæus, variety limonensis, Port Limon, height 43 mm. 152
3. Turritella exoleta Linnæus, variety limonensis, n. var., Port Limon, height 36 mm
4. Turritella altilira Conrad, variety chiriquiensis, n. var., Banana River, height 52 mm...... 150
5. Turritella mimetes Brown and Pilsbry, Gatun, height 72 mm 149
6. Turritella altilira Conrad, Mt. Hope, typical, height 50 mm 150
7. Turritella altilira Conrad, Gatun, typical, height 36 mm...... 149
8. Turritella altilira Conrad, variety chiriquiensis, n. var., Water Cay, height 116 mm. 150
9. Turritella altilira Conrad, variety chiriquiensis, n. var. Banana River, height 40 mm........... 150

Page

Fig. 10. Petaloconchus sculpturatus H. C. Lea, Water Cay, height 34 mm....... 146
11. Turritella altilira Conrad, variety costaricensis, n. var., Sousi Creek, height 34 mm 151
12. Turritella gatunensis Conrad, Water Cay, height 36.5 mm..... 148
13. Turritella gatunensis Conrad, Water Cay, height 24 mm.
14. Turritella altilira, variety chiriquiensis, n. var., Red Cliff Creek, height 33 mm....... 150
15. Petaloconchus sculpturatus H. C. Lea, East Grape Point Creek, height, 34 mm....... 146

PLATE 15. (18)

Fig. 1. Dentalium uscarianum, n. sp., Rio Cocles, natural size......... 166
2-3. Dentalium bocasensis, n. sp., Bocas del Toro, somewhat enlarged 166
4. Astralium brevispinum Lamarck, variety basalis, n. var., Old Man Sam Creek, natural size...... 162
5. Astralium brevispinum Lamarck, variety basalis, n. var., Old Man Sam Creek, natural size...... 162
6-7. Calliostoma castilla, n. sp., Port Limon, slightly enlarged.....165
8. Calliostoma limonensis, n. sp., Port Limon, about natural size 164
9-10. Calliostoma mancinella, n. sp., Red Cliff Creek, about natural size....... 164
11. Calliostoma limonensis, n. sp., Port Limon, about natural size 164
12. Turbo saltus, n. sp., Red Cliff Creek, height 17 mm...... 161
13. Scaphella costaricana, n. sp., Cocles Creek, height 29 mm..... 100
14 Ptychosalpinx ? dentalis, n. sp., Cocles Creek, about natural size 109
15. Actæon costaricensis, n. sp., Banana River, height 19.5 mm. 34a
16. Chlorostoma costaricensis, n. sp., Red Cliff Creek, diameter 16.5 mm....... 163
17. Crepitacella limonensis, n. sp., Port Limon, height 8 mm..... 143
18. Ptychosalpinx ? dentalis, n. sp., Cocles Creek, about natural size....... 109
19. Bursa crassa Dillwyn, Banana River, about natural size........ 134
20-21. Acteocina bullata Kiener, variety costaricana, n. var., Middle Creek, height 10 mm............ 34a

Page

22. Neritina viridemaris Maury, Middle Creek, enlarged 159
23. Alaba turrita Guppy, Estrella River, height 5 mm 153

PLATE 16 (19)

Fig. 1. Pecten MacDonaldi, n. sp., type, Gatun (Toro limestone) right valve, height 96 mm. 198
2. Pecten MacDonaldi, n. sp., cotype, same locality, left valve height 79 mm.
3. Pecten gatunensis, Chagres Spillway, right valve, height 62 mm 197
4. Pecten gatunensis, same locality, left valve, height 48 mm.
5. Pecten levicostatus Toula, Hill No. 2. Banana River, slightly reduced 199
6. Pecten levicostatus Toula, same locality, left valve, slightly reduced
7. Pecten levicostatus Toula, same locality, right valve slightly reduced

PLATE 17 (20)

Fig. 1. Amusium luna Brown and Pilsbry, Chagres Spillway, somewhat reduced 205
2. Pecten preglyptus, n. sp., Cocles Creek, natural size (type).. 202
3. Amusium bocasensis, n. sp., Bocas del Toro, natural size, cotype 206
4. Amusium bocasensis, n. sp., Bocas del Toro, interior of right valve.
5. Pecten coralliphila, n. sp., type, Port Limon, slightly enlarged 199
6. Pecten coralliphila, n. sp., Port Limon, left valve 199
7. Pecten preglyptus, n. sp., interior view of type, natural size 202

PLATE 18 (21)

Fig. 1. Ostrea megodon Hanley, Banana River, natural size 195
2. Glycymeris canalis Brown and Pilsbry, Comadre Creek, about natural size 177

Page

3. Glycymeris canalis Brown and Pilsbry, Banana River, about natural size.................. 177
4. Glycymeris canalis Brown and Pilsbry, variety, East Grape Point Creek.............................. 177
5. Glycymeris canalis Brown and Pilsbry, variety, East Grape Point Creek.............. 177
6-7. Glycymeris canalis Brown and Pilsbry, Banana River......... 177
8. Pecten costaricensis, n. sp., Red Cliff Creek, right valve........ 201
9. Pecten costaricensis, n. sp., Red Cliff Creek, left valve.
10. Pecten costaricensis, n. sp., Red Cliff Creek, right valve.
11. Pecten costaricensis, n. sp., Red Cliff Creek, left valve.
12. Leda ensinoides, n. sp., Banana River, length 54 mm........... 174
13. Glycymeris castaneus Lamarck, Banana River, length 30 mm. 180
14. Glycymeris castaneus Lamarck, Banana River, length 23 mm.
15. Leda Balboæ Brown and Pilsbry, Banana River, enlarged..... 173
16. Pecten almirantensis, n. sp., Bocas del Toro, heigth 4.75 mm. 203
17. Pecten aotus, n. sp., Port Limon, height 4.50 mm....... 204
18. Pecten aotus, n. sp., Port Limon, 4.75 mm.
19. Leda quitanensis, n. sp., Quitana Creek, length 26 mm........ 174
20. Leda Davilæ, n. sp., Bocas del Toro, length 5.75 mm........... 173
21-22-23-24. Nucula cahuitensis, n. sp., Saury, length 3.50 mm..... 171
25. Nucula tenuisculpta Gabb, Red Cliff Creek, length 4.00 mm. 172

PLATE 19 (22)

Fig. 1. Glycymeris carbasina Brown and Pilsbry, East Grape Point Creek, about natural size............ 179
2. Glycymeris carbasina Brown and Pilsbry, same locality, about natural size....................... 179
3-4. Glycymeris jamaicensis, Red Cliff Creek, about natural size 178
5. Glycymeris carbasina Brown and Pilsbry, East Grape Point Creek, small shell about natural size 179
6-7. Glycymeris decussatus Lamarck, Old Man Sam Creek, natural size.......................... 180

PLATE 20 (23)

Fig. 1. Spondylus chiriquiensis, n. sp., Water Cay, height 151 mm... 206
2. Spondylus chiriquiensis, n. sp., young shell to show the small foliaceous attachment area.
3. Thracia Tristani, n. sp., Rio Betey, length 42 mm............... 211

Page

4. Crassatellites Reevei Gabb, Banana River, slightly reduced.. 212
5. Spondylus chiriquiensis, n. sp., Water Cay, young right valve.............................. 206
6. Spondylus chiriquiensis, n. sp., Water Cay, young left valve.

PLATE 21 (24)

Fig. 1. Spondylus gumanomocon Brown and Pilsbry, Hone Walk Creek, shell greatly reduced....... 207
2. Ostrea costaricensis, n. sp., Rio Blanco, about natural size... 196
3. Placunanomia lithobleta Dall, Banana River, height 36 mm.. 210
4. Placunanomia lithobleta Dall, Banana River, height 49 mm
5. Placunanomia lithobleta Dall, interior of same specimen as figure 3.
6. Anomia simplex d'Orbigny. Middle Creek, height 34 mm..... 209
7. Corbula gatunensis Toula, Gatun, length 21 mm.
8. Corbula Dietziana C. B. Adams, Port Limon, length 15.5 mm. 268
9. Corbula orosi, n. sp., type, Banana River, length 19.5 mm ... 269
10. Corbula orosi, n. sp., type, Banana River, length 19 mm.
11. Labiosa lineata Say, Saury Creek, length 44 mm.......... 264
12. Corbula hexacyma Brown and Pilsbry, Gatun, length 26 mm. 269
13. Corbula hexacyma Brown and Pilsbry, Gatun, length 18 mm.

PLATE 22 (25)

Fig. 1. Arca occidentalis Phil., Port Limon, somewhat enlarged...... 181
2. Arca umbonata Lamarck, East Grape Point Creek, slightly enlarged 182
3. Arca auriculata Lamarck, Old Man Sam Creek, young shell.. 190
4. Arca Mauryæ, n. sp., Port Limon, right valve of type, length 24 mm.................................... 182
5. Arca candida Gmelin, Port Limon, left valve, length 18 mm. 183
6. Arca candida Gmelin, Port Limon, right valve length 13 mm.
7. Arca Mauryæ, n. sp., interior view of type............ 182
8. Arca honensis, n. sp., Hone Walk Creek, left valve type, slightly reduced........................ 187
9. Arca honensis, n. sp., same locality, right valve of cotype, slightly reduced........................ 187
10. Arca dariensis Brown and Pilsbry, Water Cay, about natural size 184

Page

11. Arca dariensis Brown and Pilsbry, Water Cay, about natural size 184
12. Arca dariensis Brown and Pilsbry, Gatun, about natural size.
13. Arca dariensis Brown and Pilsbry, Gatun, about natural size.

PLATE 23 (26)

Fig. 1. Arca Veatchi, n. sp., Water Cay, left valve of type, length 51 mm.................. 189
2. Arca Veatchi, n. sp., Water Cay, interior of left valve of type.
3. Arca Veatchi, n. sp., Water Cay, right valve of type.
4-5. Arca golfoyaquensis Maury, variety medioamericana, n. var., Hone Walk Creek, valve of type, length 63 mm.................. 188
6. Arca golfoyaquensis Maury, variety medioamericana, n. var., Hone Walk Creek, left valve of type, same locality.
7-8. Arca actinophora Dall, Red Cliff Creek, nearly natural size.. 185

PLATE 24. (27)

Fig. 1. Arca cacica, n. sp., type, Comadre Creek, length 36 mm...... 190
2. Arca Pittieri Dall, Saury Creek, natural size.................. 192
3-4-5. Arca Pittieri Dall, Hill 1a, Banana River, natural size.
6. Arca Pittieri Dall, Hill 1, Banana River, natural size.
7. Arca Hindsi, n. sp., type, East Grape Point Creek, natural size 193
8. Arca Hindsi, n. sp., co-type, Rio Betey, natural size.
9. Arca Hindsi, n. sp., co-type, Hill 3, Banana River, natural size.
10. Arca Lloydi, n. sp., co-type, Red Cliff Creek, length 18 mm.. 192
11. Arca Lloydi, n. sp., type, same locality, diameter 18 mm.
12. Arca Lloydi, n. sp., co-type, same locality, length 15.5 mm.
13. Arca Henekeni Maury, Water Cay, length 30 mm................ 186
14. Arca Henekeni Maury, Water Cay, length 28 mm.

PLATE 25 (28)

Fig. 1. Arca costaricensis, n. sp., type, Hill 1a, Banana River, natural size 186

Page

2. Arca costaricensis, n. sp., co-type, Hill 1a, Banana River natural size.
3. Arca actinophora Dall, typical form, Mt. Hope, slightly reduced... 185
4. Arca MacDonaldi Dall, Hill No. 3, Banana River, nearly natural size, interior view to show high, cardinal area................ 194
5. Arca MacDonaldi Dall, exterior of the same specimen.
6. Arca MacDonaldi Dall, variety subreversa, n. var., Rio Betey exterior of left valve.
7. Arca MacDonaldi Dall, variety subreversa n. var., Hill No. 3 Banana River, interior of right valve, to show form and low cardinal area.
8. Glycymeris Lloydsmithi Pilsbry and Brown, Red Cliff Creek, right valve, slightly reduced....... 181
9. Glycymeris Lloydsmithi Pilsbry and Brown, same locality left valve.
10. Glycymeris Lloydsmithi Pilsbry and Brown, same locality right valve.

PLATE 26 (29)

Fig. 1. Tellidora cristata Recluz, Hill 3, Banana River, nearly natural size.....................................254
2. Tellidora cristata Recluz, Hill 1a, Banana River, nearly natural size.
3. Tellina dariena Conrad, Water Cay, natural size.................. 252
4. Tellina lepidota Dall, Water Cay, length 24 mm.................. 251
5. Tellina lepidota Dall, Water Cay, length 21 mm.
6. Tellina costaricana, n. sp., Banana River, about natural size 251
7. Tellina rovala, n. sp., Water Cay, slightly enlarged............ 249
8. Tellina rovala, n. sp., Water Cay, (type) slightly enlarged.
9. Tellina costaricana, n. sp., Banana River, about natural size 251
10. Tellina crystallina Wood, Banana River, enlarged nearly twice.. 249
11. Macoma panamensis Dall, variety canalis n. var., Mt. Hope, length 15 mm.................. 257
12. Tellina umbra Dall, East Grape Point Creek, enlarged about 3½ times................ 253
13. Macoma gatunensis Toula, Banana River, about natural size 257
14. Macoma costaricana, n. sp., Rio Betey, about natural size..... 256

Page

15. Tellina umbra Dall, East Grape Point Creek, enlarged about 3½ times.................................. 253
16. Macoma costaricana, n. sp., Banana River, about natural size 256
17. Tellina nasua, n. sp., Red Cliff Creek, about natural size...... 250
18. Strigilla musanica, n. sp., Banana River, length 13 mm....... 255
19-20. Venericardia Conradiana Gabb, variety limonensis, n. var., Port Limon, length 7 mm........... 217
21. Chione grus Holmes, variety, Red Cliff Creek, enlarged about 4 times.................................. 248
22. Cardita caribbeanensis, n sp., Banana River, length 18 mm. 214
23-24. Limopsis monilis, n. sp,, Old Man Sam Creek, length 1.75 mm.............. 177

PLATE 27 (30)

Fig. 1. Cardium spinosum Meuschen, var. Turtoni Dall, Port Limon about natural size..................... 228
2. Cardium dominicense Gabb, East Grape Point Creek, slightly reduced............................. 225
3. Cardium costaricauum, n. sp., East Grape Point Creek height 24 mm.................................... 226
4-5. Cardium stiriatum Brown and Pilsbry, Banana River, slightly reduced.............................. 225
6. Cardium medium Linné, Port Limon, about natural size....... 226
7. Protocardia gurabica Maury, Gatun, length 29 mm.............. 229
8. Protocardica gurabica Maury, Water Cay, length 25 mm.
9. Protocardia gurabica Maury, Water Cay, diameter 19 mm.
10. Cardium heredium, n. sp., Rio Betey, length 11.50 mm........ 227
11-12. Cardium serratum Linné, Middle Creek, natural size......... 228
13. Protocardia costaricensis, n. sp., Comadre Creek, length 21 mm........................ 229

PLATE 28 (31)

Fig. 1. Mactra estrellana, n. sp , Estrella River, length 50 mm......... 263
2. Mactra exoleta Gray, Boucary Creek, about natural size....... 262
3. Mactra alata Spengler, Banana River, about natural size...... 263
4. Mactra sincola, n. sp., Saury Creek, length 36 mm 264
5. Echinochama yaquensis Maury, Old Harbor....................... 219

Page

6. Plicatula marginata Say, Water Cay, the lower or attached valve, enlarged about 2½ time.... 208
7. Plicatula marginata Say, Water Cay, the lower or attached valve, enlarged about 2½ times. 208
8. Echinochama antiquata Dall, Rio Blanco.......................... 218
9. Pteria inornata Gabb, Red Cliff Creek, natural size. 195
10. Limæa solida Dall, Red Cliff Creek, height 2.5 mm............. 209
11. Chama congregata Conrad, Red Cliff Creek, enlarged about twice................................... 218
12. Corbula oropendula, n. sp., Banana River, length 6.5 mm..... 267
13. Corbula oropendula, n. sp., Banana River, same valve but less magnified, length 6.5 mm
14. Corbula oropendula, n. sp., same locality, right valve, 6.5 mm.
15. Corbula cf. vieta Guppy, Banana River, right valve, length 6.25 mm.............................. 266
16. Corbula cf. vieta Guppy, Banana River, left valve, length 6.25 mm.
17. Leda Dalliana, n. sp., Port Limon, length 10.50 mm............ 175
18. Mesodesma costaricensis, n. sp., Banana River, length 22 mm.. 265
19. Nucula orbicella, n. sp., Port Limon, length 9.5 mm............ 171
20. Nucula orbicella, n. sp., Port Limon, length 11 mm.
21-22. Yoldia bocasensis, n. sp., Bocas del Toro, length 9.5 mm... 176
23. Mulinia lateralis Say, variety sauryensis, n. var., Saury Creek, about natural size............ 265
24. Mulinia lateralis Say, variety sauryensis, n. var., Saury Creek, about natural size.
25. Corbula viminea Guppy, Middle Creek, length 15 mm......... 270
26-27. Corbula oropendula, n. sp., Saury Creek, length 9 mm...... 267

PLATE 29 (32)

Fig. 1. Semele lævis Sowerby, variety costaricensis, n. var., Hill 3, Banana River, length 72 mm...... 258
2. Semele Claytoni Maury, Hotel Creek, natural size.............. 259
3. Metis barba, n. sp., Rio Betey (type), right valve, length 48 mm.. 255
4. Metis barba, n. sp., Rio Betey (type), left valve, length 48 mm.

		Page
5.	Sanguinolaria alouatta, n. sp., Banana River, right valve, length 60 mm	260
6.	Sanguinolaria alouatta, n. sp., Banana River, left valve, length 54 mm.	
7.	Psammosolen gatunensis Toula, variety costaricensis, n. var. Rio Betey, length 63 mm	260
8.	Semele Sayi Toula, Sousi Creek, slightly enlarged	258
9.	Tagelus cebus, n. sp., Rio Betey, length 36 mm	261
10.	Abra triangulata Dall, Bocas del Toro, length 7.25 mm	259
11.	Crassatellites midiensis, n. sp., Middle Creek, length 3.25 mm	213
12.	Crassatellites bowdenensis Dall, variety costaricensis, n. var. length 3.50 mm	213

PLATE 30. (33)

Fig. 1.	Antigona multicostata Sowerby, Water Cay	239
2.	Chione Rowleei, n. sp., Banana River, length 42 mm	244
3.	Antigona Harrisiana, n. sp., Port Limon, length 21.5 mm	241
4.	Antigona rugosa Gmelin, Port Limon, about ½ natural size	240
5.	Antigona Blandiana Guppy, Comadre Creek, length 30 mm	241
6.	Antigona Blandiana Guppy, Port Lomon, length 24 mm.	
7.	Chione mactropsis Conrad, Gatun, length 30 mm	245
8.	Chione mactropsis Conrad, Sousi Creek, length 51 mm.	
9.	Chione holocyma Brown and Pilsbry, Gatun, length 36.5 mm	247
10.	Antigona tarquina Dall, Saury Creek, about natural size	240

PLATE 31 (34)

Fig. 1.	Dosinia acetabulum Conrad, Rio Betey, somewhat reduced	231
2.	Cyclinella beteyesis, n. sp., Rio Betey, height 39 mm	242
3.	Pitaria circinata Born, Saury Creek, about natural size	236
4.	Clementia dariena Conrad, Sousi Creek, height 60 mm	232
5.	Pitaria Hillii Dall, variety musanica, n. var., Banana River, length 42 mm	237
6-7.	Macrocallista maculata Linnæus, Middle Creek, about natural size	234
8.	Cyclinella subquadrata Hanley, variety quitana, n. var., Quitana Creek, height 28 mm	243

Page

9. Pitaria circinata Born, Saury Creek, about natural size.........236
10. Pitaria boucaryensis, n. sp., Boucary Creek, about natural size.. 239
11. Pitaria Guppyana Gabb, Port Limon, about natural size. 237

PLATE 32 (35)

Fig. 1. Callocardia gatunensis Dall, Banana River, about natural size.. 235
2-3. Pitaria VanWinkleæ, n. sp., Banana River, about natural size.. 238
4. Chione costaricensis, n. sp., Banana River, length 34 mm..... 245
5. Phacoides costaricensis, n. sp., Middle Creek, length 11.50 mm.. 222
6. Phacoides bocasensis, n. sp., Bocas del Toro, length 10.00 mm.. 223
7. Chione hotelensis, n. sp., Hotel Creek, slightly reduced...... 247
8. Cardita matima, n. sp., Old Man Sam Creek, about natural size.. 215
9-10. Chione chiriquiensis, n. sp., Water Cay, length 13.75 mm.. 248
11. Myrtæa limoniana Dall, Red Cliff Creek, height 9.50 mm..... 221
12-13. Venericardia Terryi, n. sp., Quitana Creek, natural size.... 216
14. Venericardia scabricostata Guppy, East Grape Point Creek, about natural size.................... 216
15. Diplodonta collina, n. sp., Middle Creek, height 6.75 mm..... 220
16. Phacoides radians Conrad, variety medioamericanus, n. sp., Middle Creek, height 9 mm........ 221
17. Venericardia scabricostata Guppy, Comadre Creek, about natural size.. 216
18. Gafrarium limonense, n. sp., Port Limon, length 4.75 mm 233
19. Gafrarium altum Dall, variety costaricense, n. var., Estrella River, enlarged about 3 times...... 234
20. Divaricella quadrisulcata d'Orbigny, Middle Creek, height 14 mm.. 224
21. Diplodonta insula, n. sp., Water Cay, height 6.5 mm.............220
22. Gafrarium altum Dall, variety costaricense, n. sp., Middle Creek, height 4.75 mm.............. 234
23. Myrtæa limoniana Dall, Port Limon.. 221
24. Phacoides actinus Dall, Bocas del Toro, height 4.50 mm....... 224

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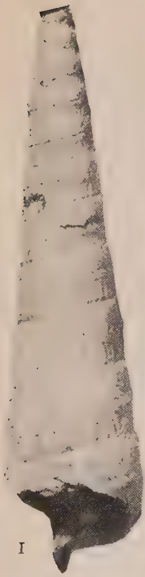
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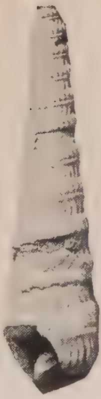
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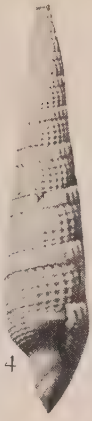
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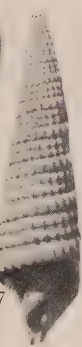
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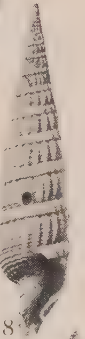
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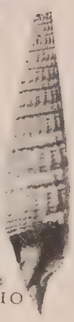
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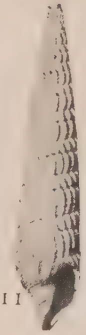
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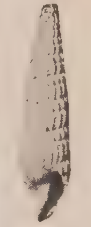
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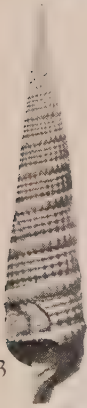
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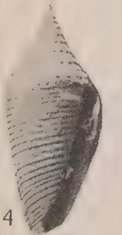
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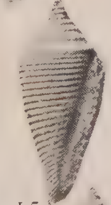
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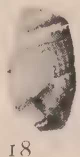
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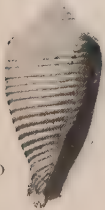
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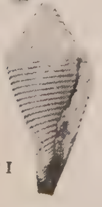
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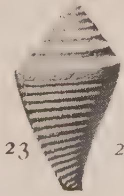
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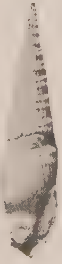
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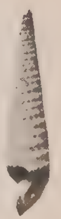
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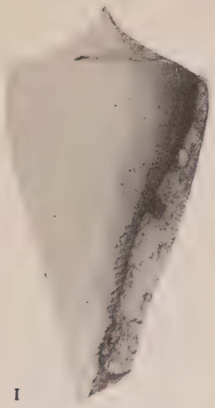

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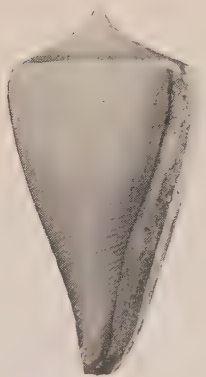

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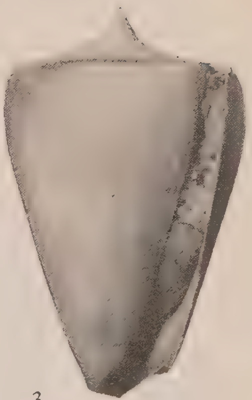

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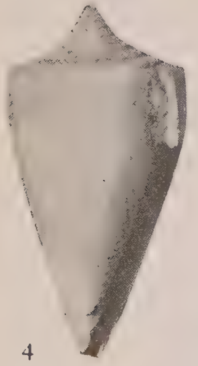

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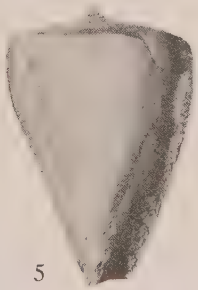

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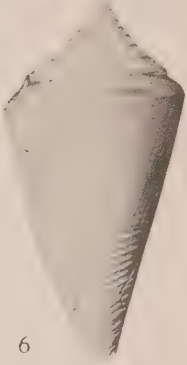

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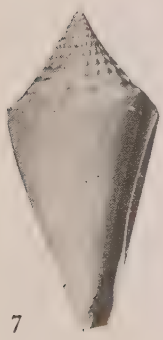

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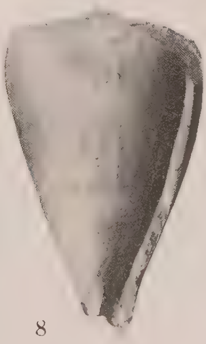

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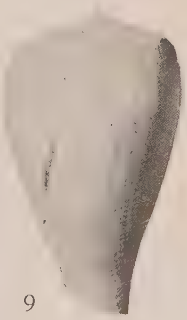

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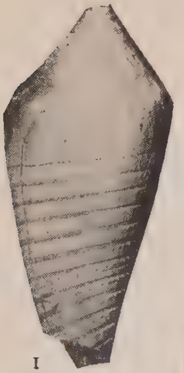
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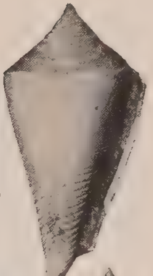
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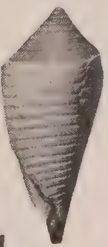
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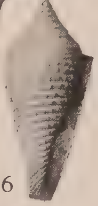
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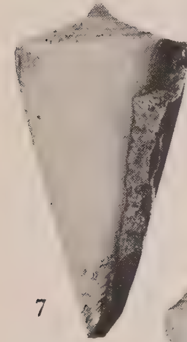
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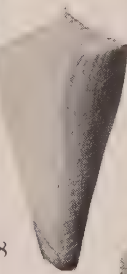
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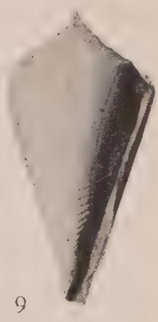
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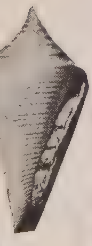
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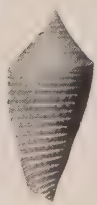
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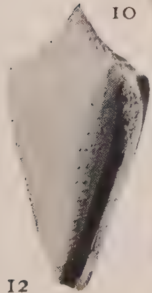
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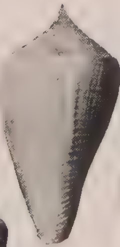
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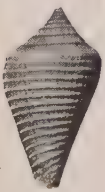
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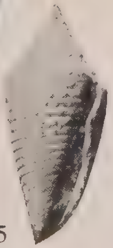
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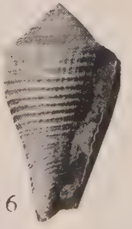
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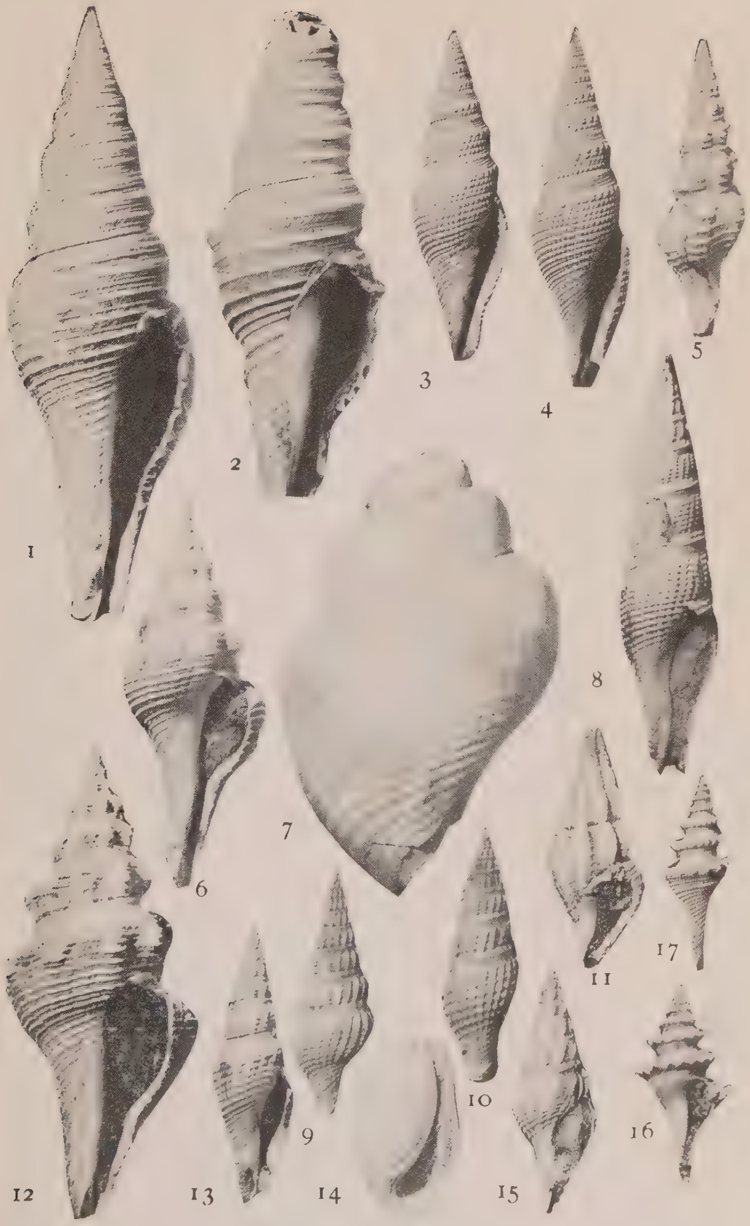

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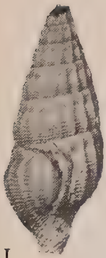
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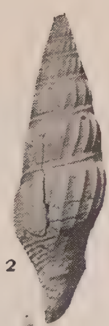
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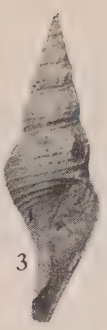
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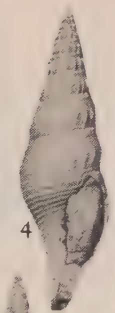
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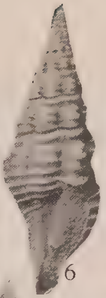
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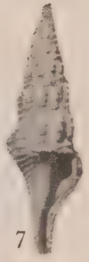
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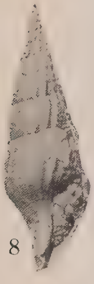
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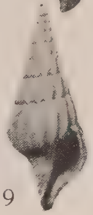
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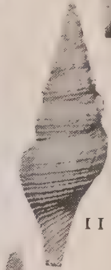
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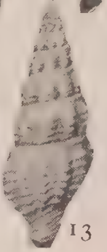
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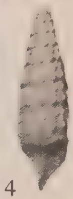
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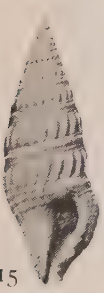
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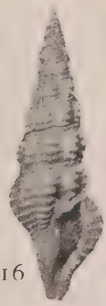
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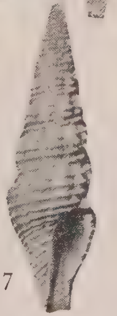
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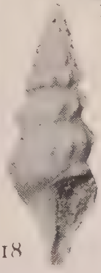
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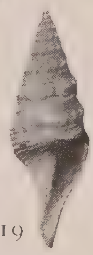
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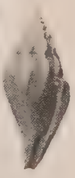
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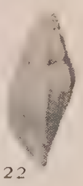
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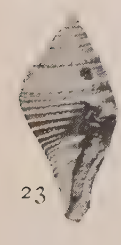
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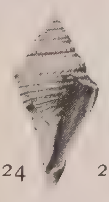
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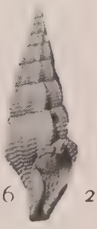
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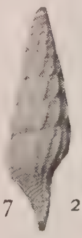
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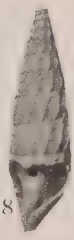
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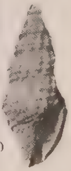
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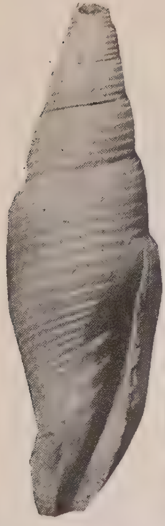
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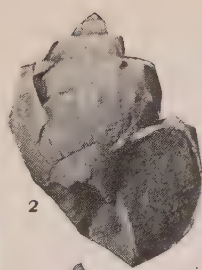
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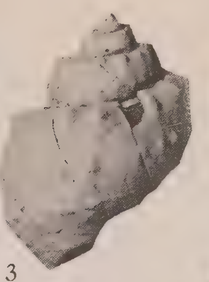
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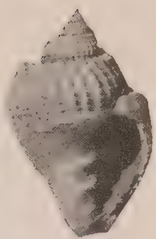
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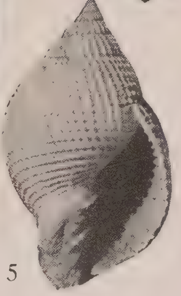
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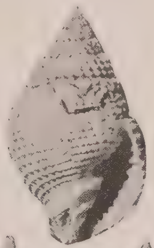
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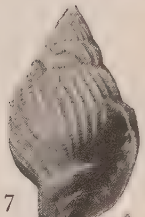
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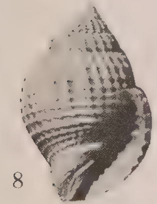
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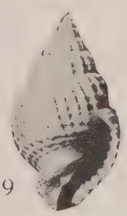
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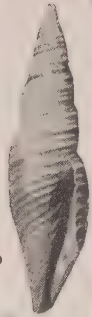
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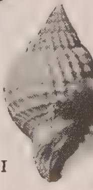
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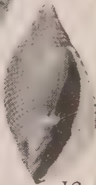
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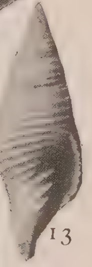
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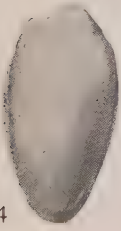
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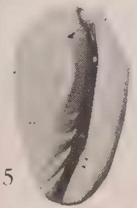
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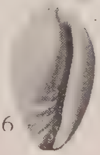
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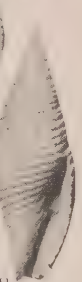
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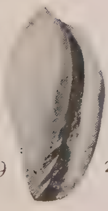
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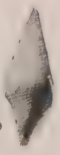
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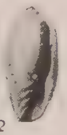
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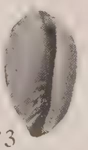
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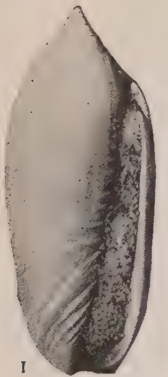
Pl. 10, Vol. 9, Bull. Amer. Paleont. No. 39, Pl. 7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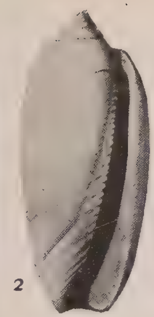
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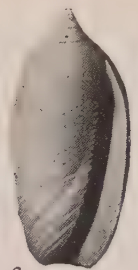
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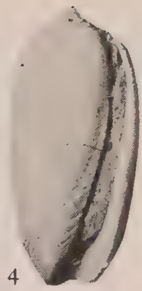
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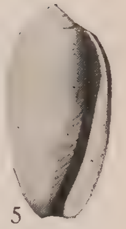
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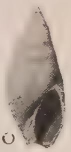
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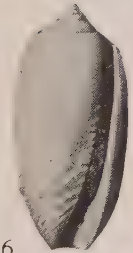
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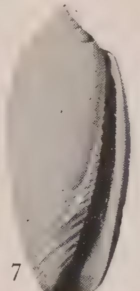
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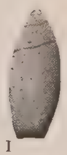
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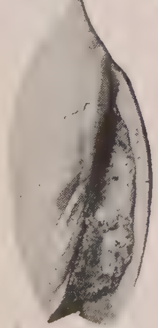
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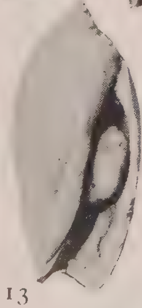
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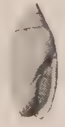
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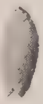
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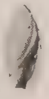
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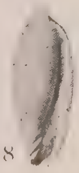
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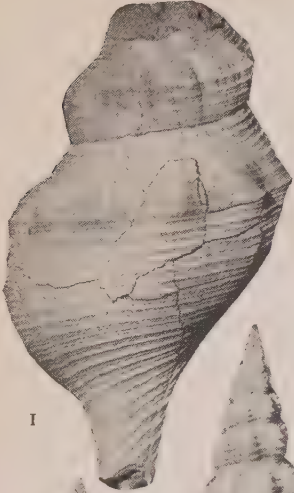
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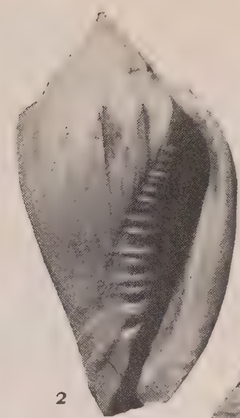
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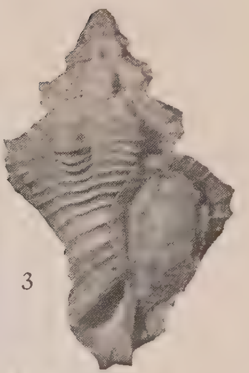
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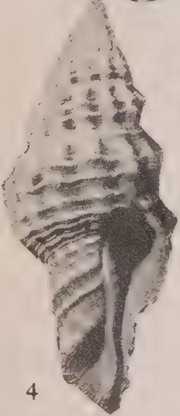
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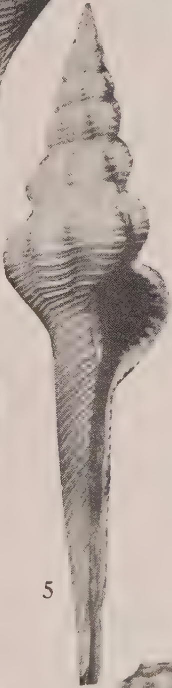
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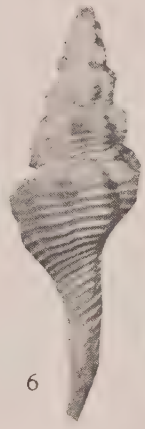
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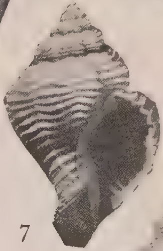
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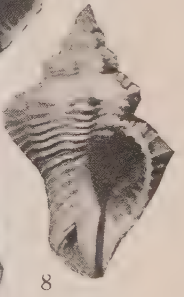
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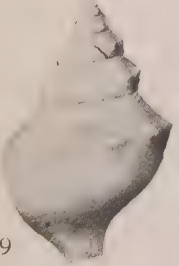
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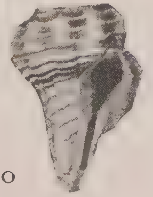
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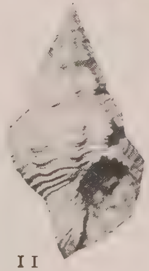
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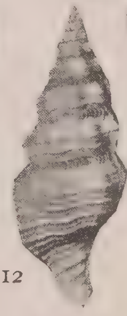
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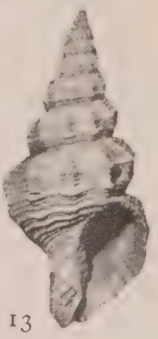
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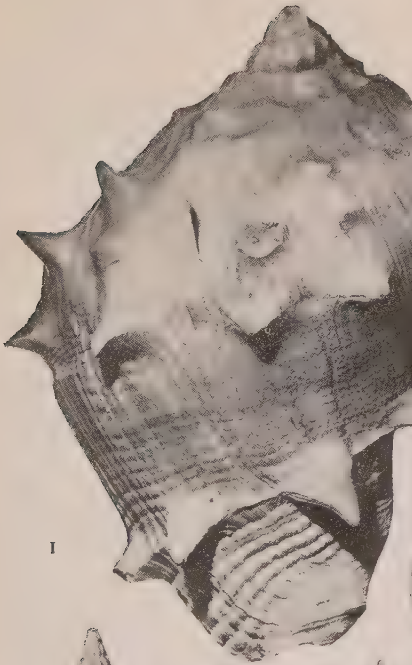

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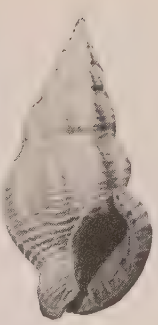

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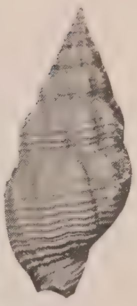

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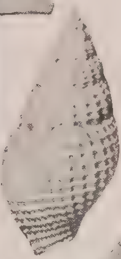

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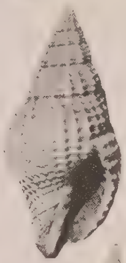

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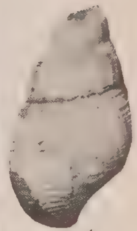

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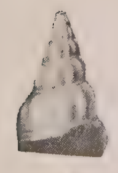

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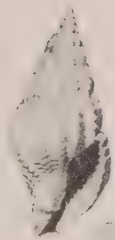

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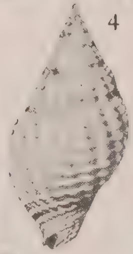

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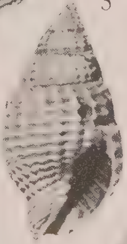

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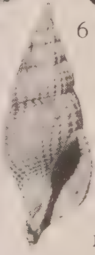

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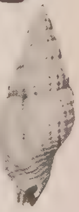

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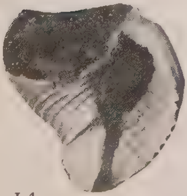

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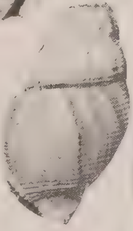

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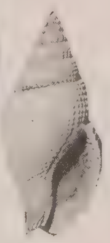

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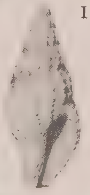

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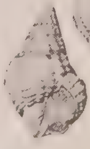

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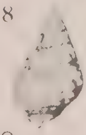

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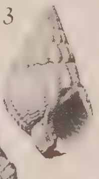

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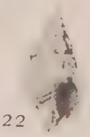

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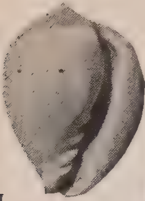
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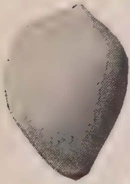
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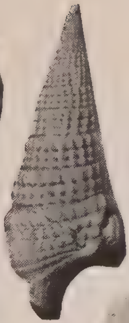
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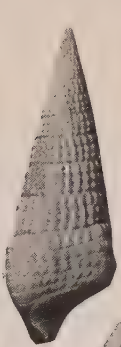
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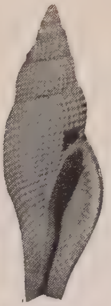
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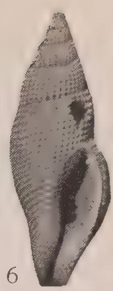
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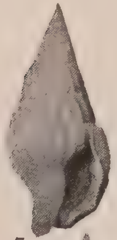
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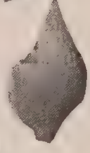
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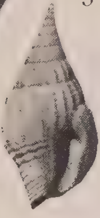
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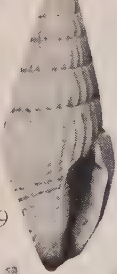
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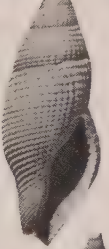
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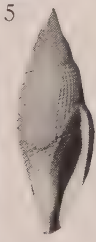
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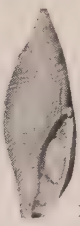
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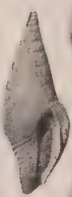
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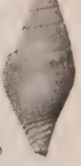
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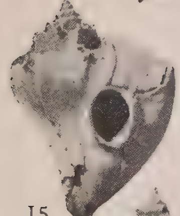
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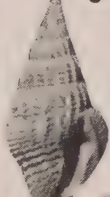
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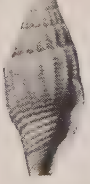
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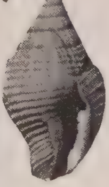
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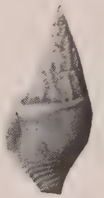
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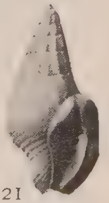
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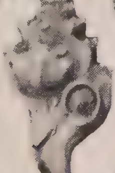
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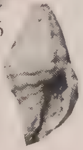
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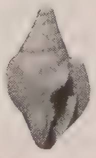
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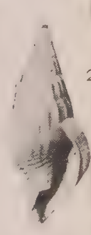
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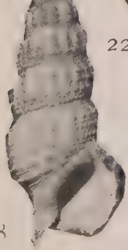
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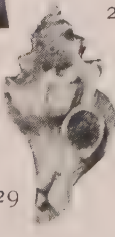
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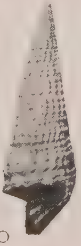
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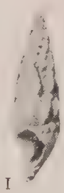
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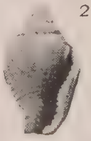
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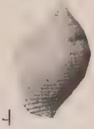
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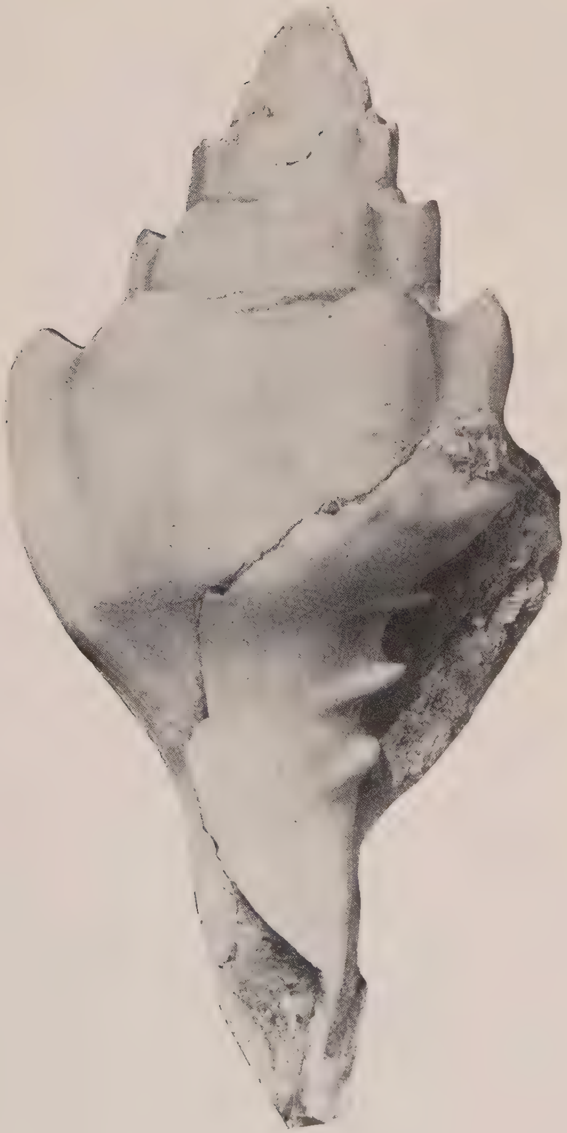

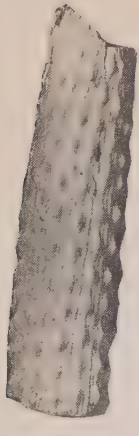

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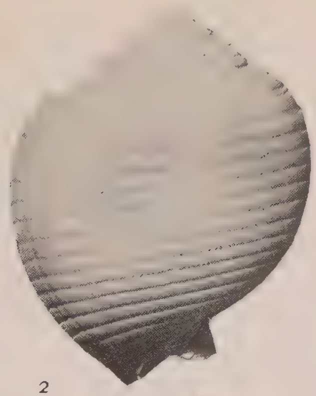

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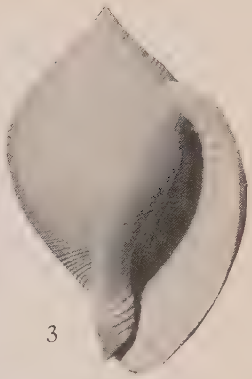

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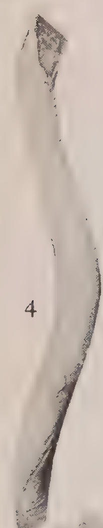

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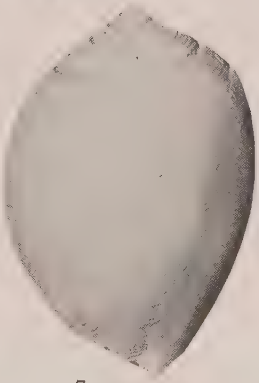

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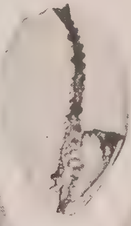

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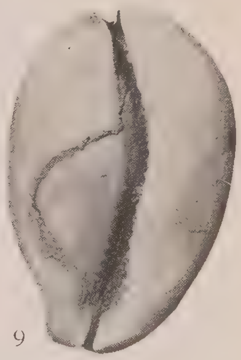

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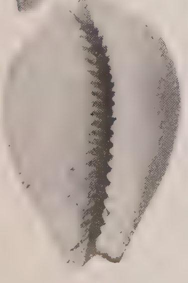

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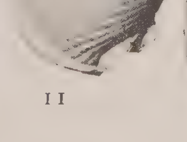

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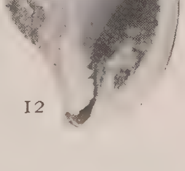

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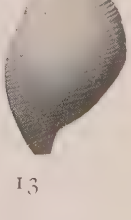

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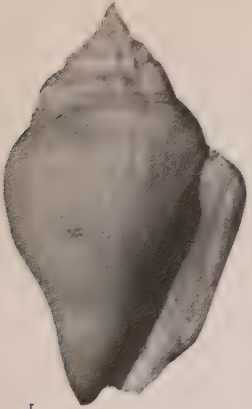
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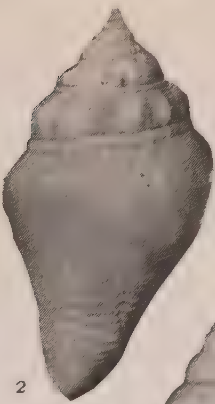
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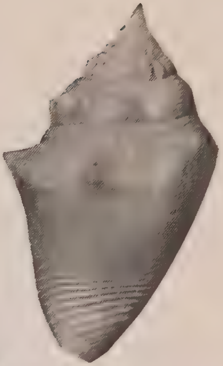
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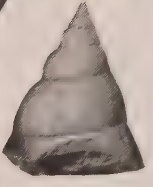
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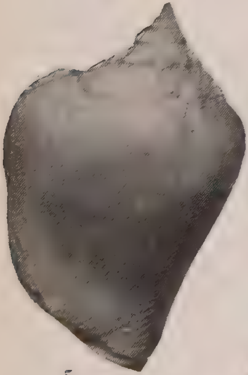
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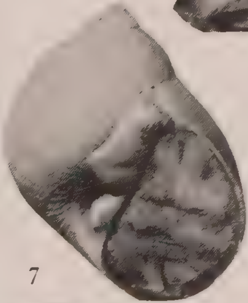
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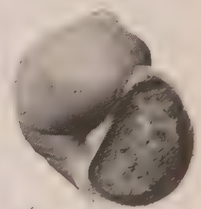
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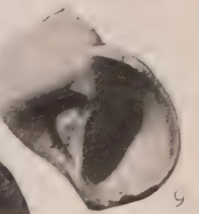
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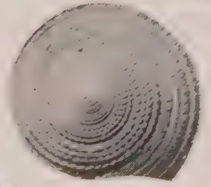
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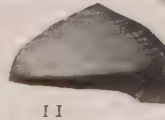
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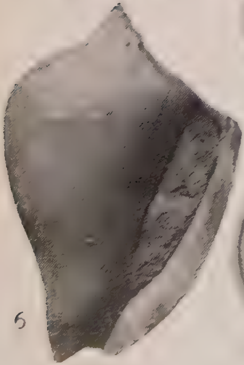
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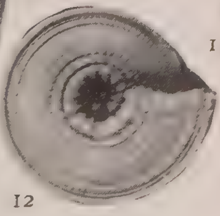
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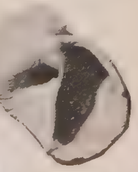
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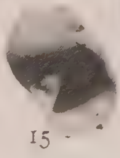
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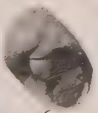
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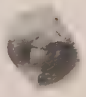
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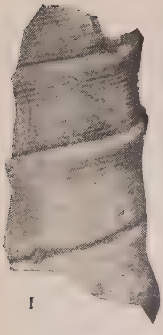
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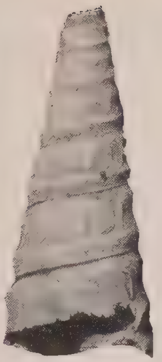
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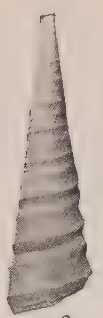
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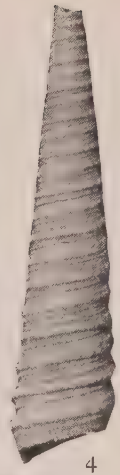
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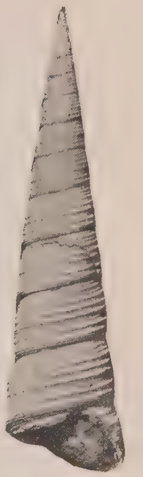
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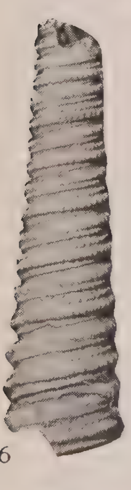
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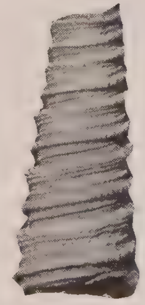
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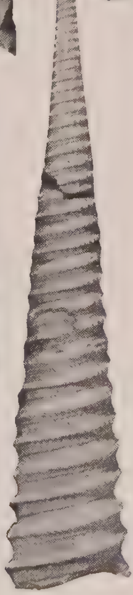
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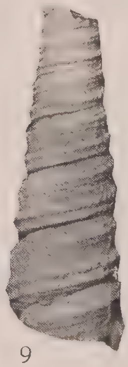
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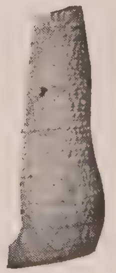
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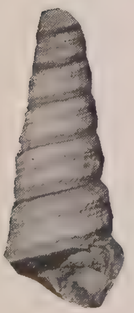
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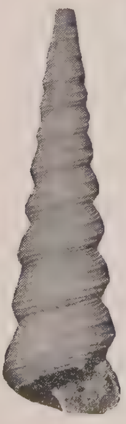
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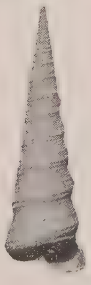
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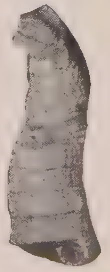
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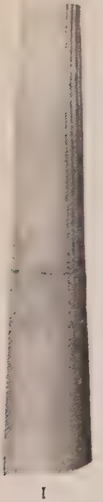
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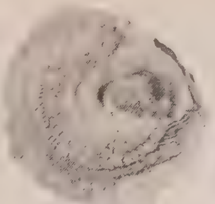
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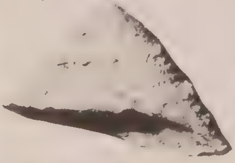
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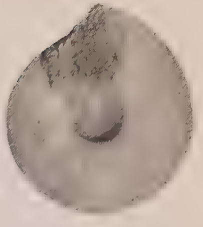
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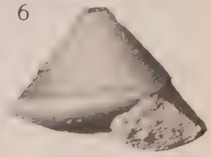
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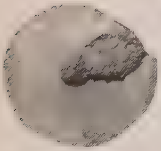
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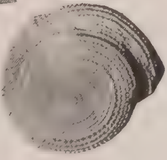
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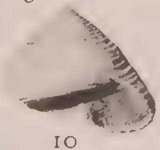
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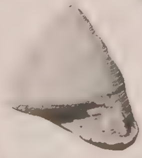
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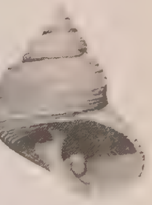
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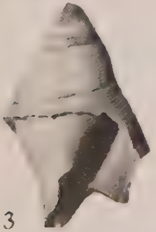
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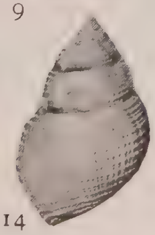
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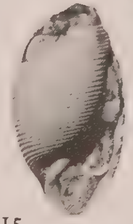
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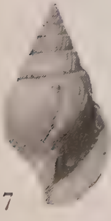
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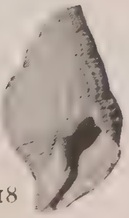
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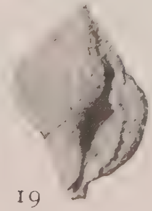
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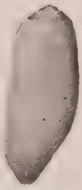
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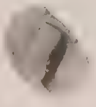
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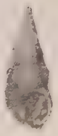
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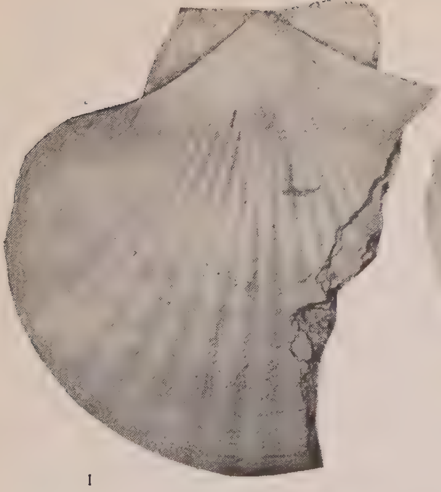

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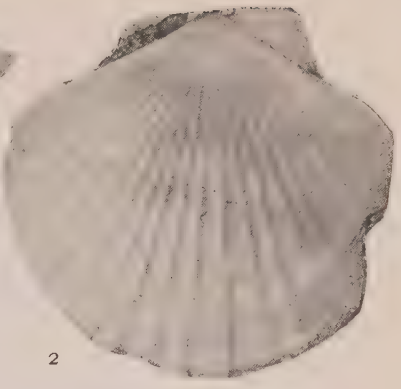

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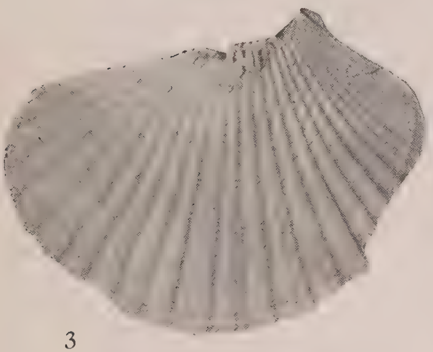

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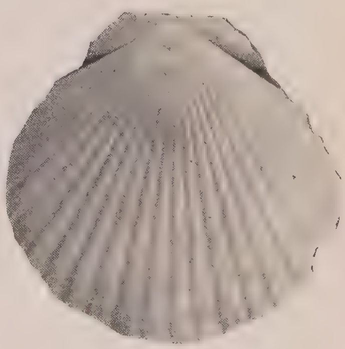

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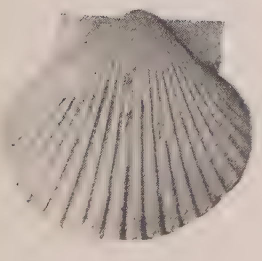

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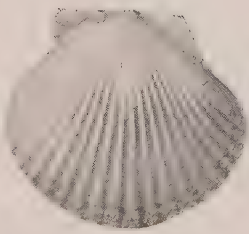

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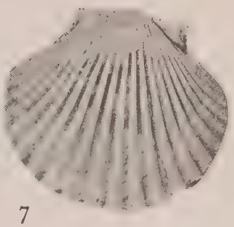

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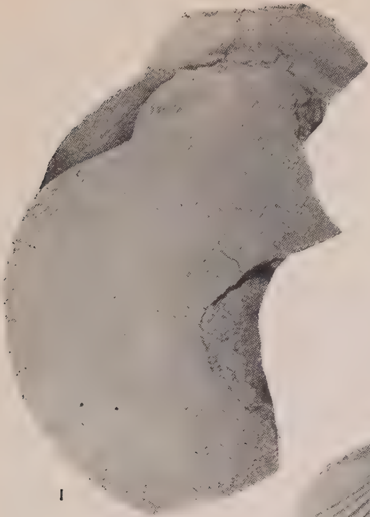

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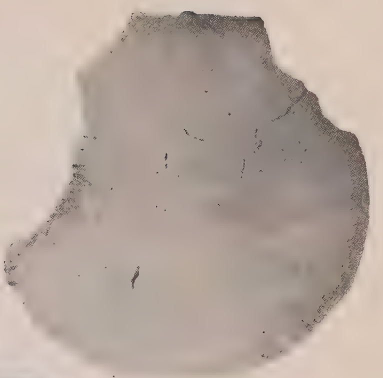

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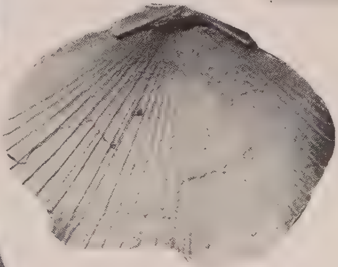

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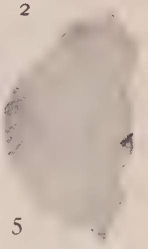

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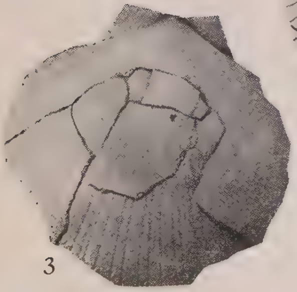

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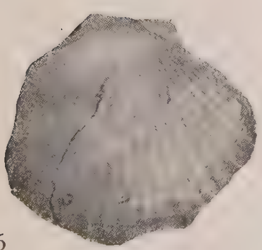

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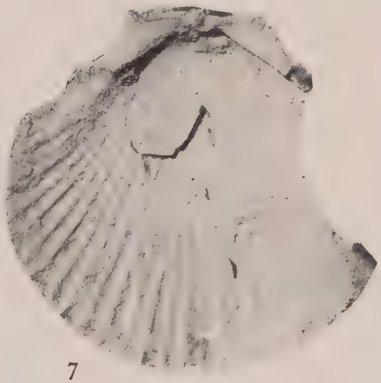

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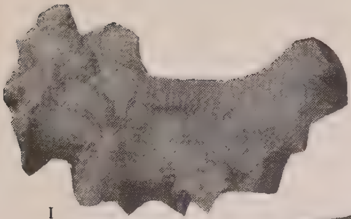
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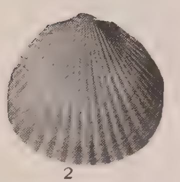
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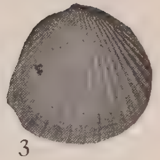
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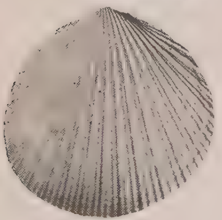
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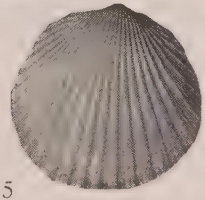
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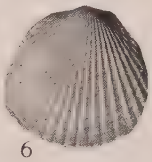
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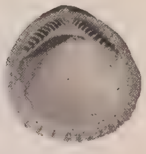
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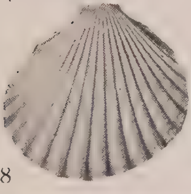
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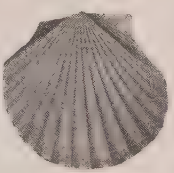
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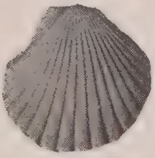
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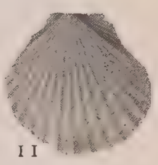
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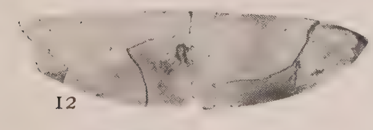
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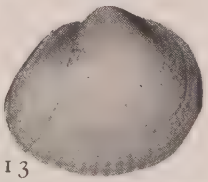
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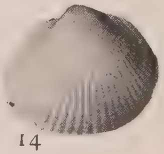
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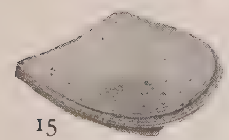
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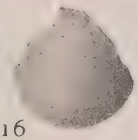
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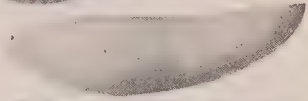
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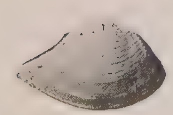
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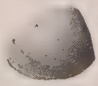
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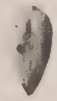
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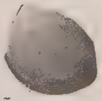
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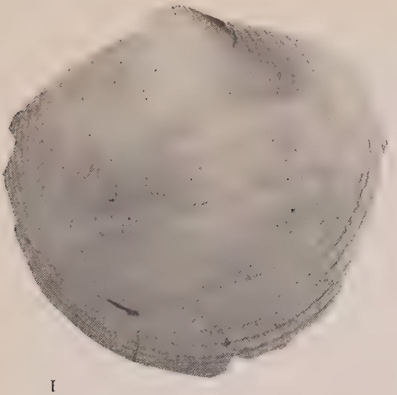
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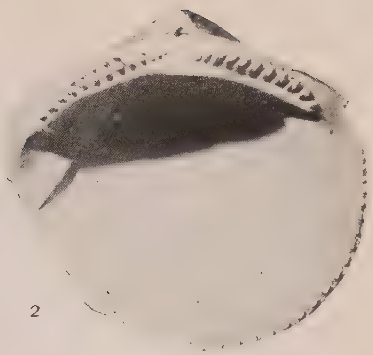
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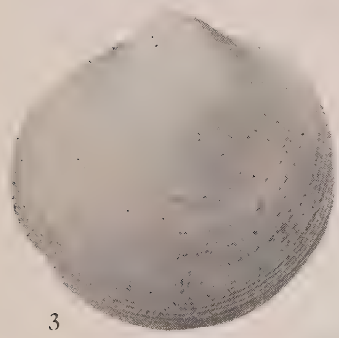
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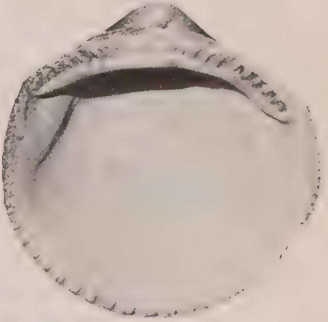
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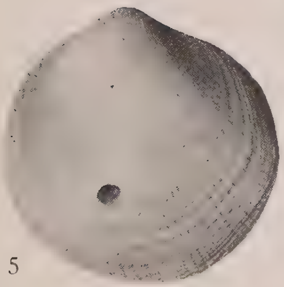
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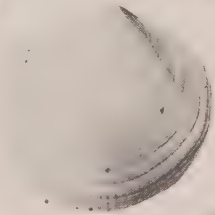
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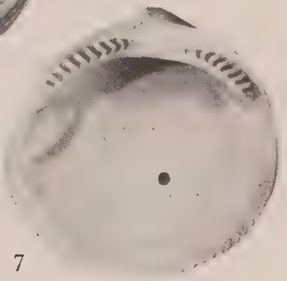
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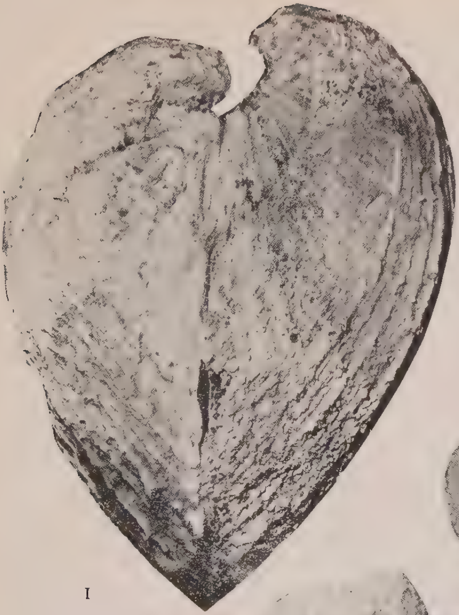
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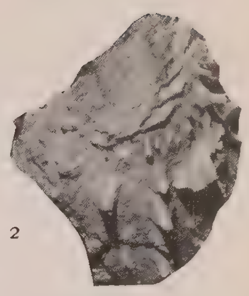
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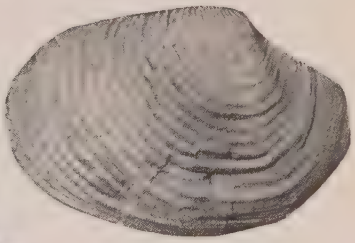
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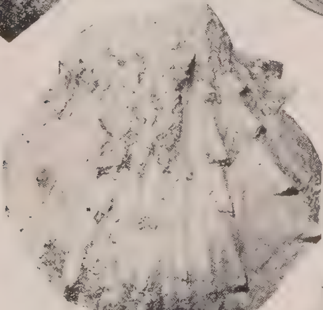
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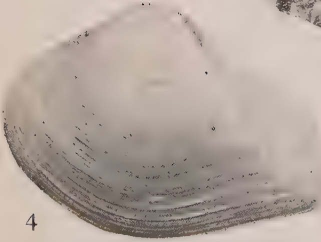
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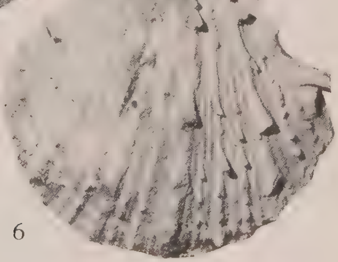
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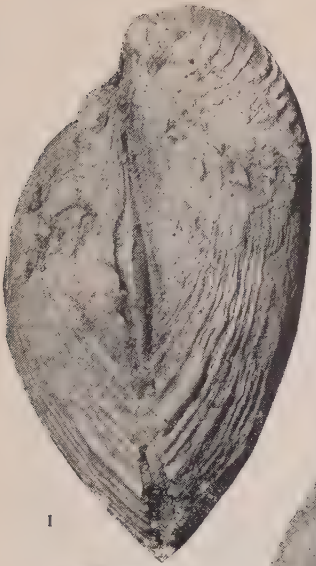

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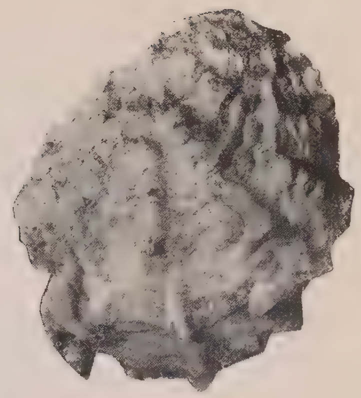

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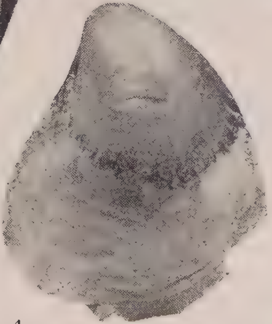

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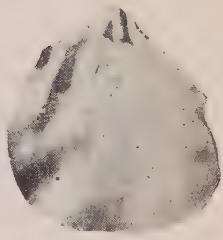

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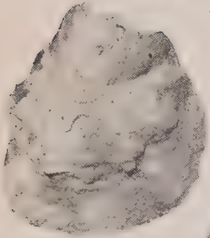

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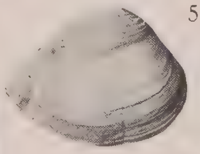

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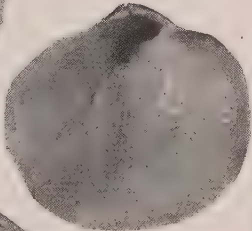

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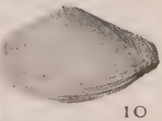

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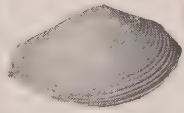

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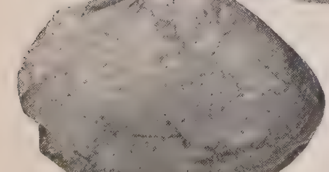

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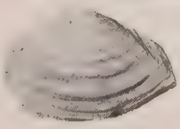

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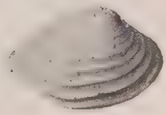

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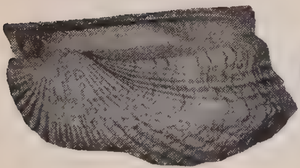
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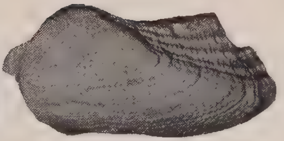
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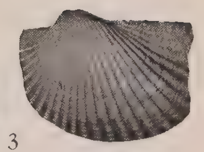
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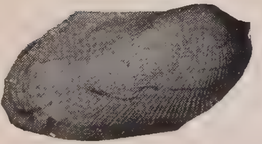
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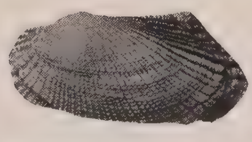
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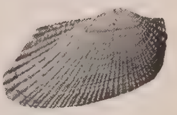
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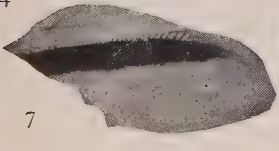
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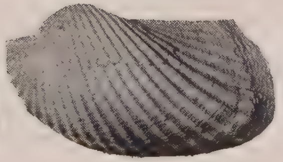
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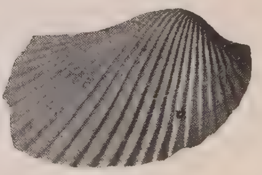
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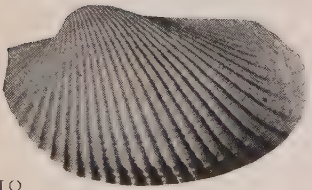
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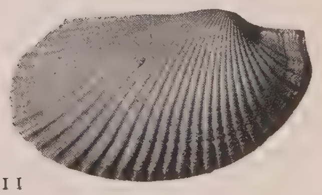
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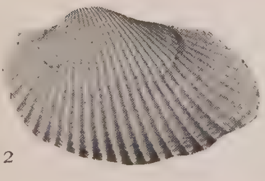
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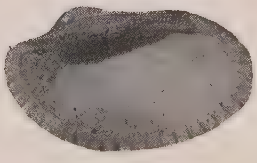
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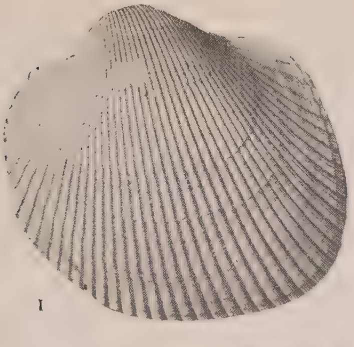

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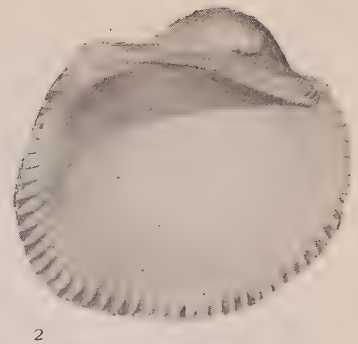

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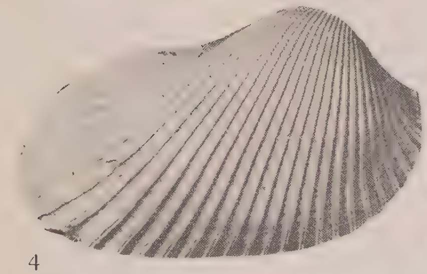

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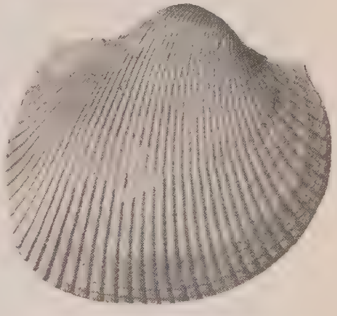

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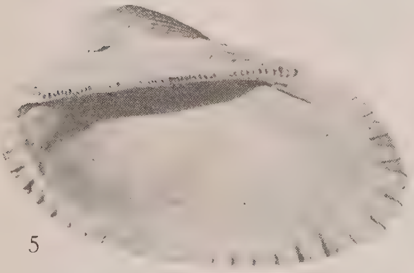

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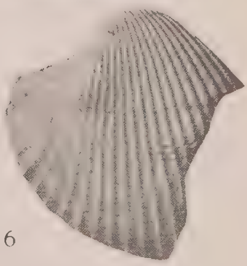

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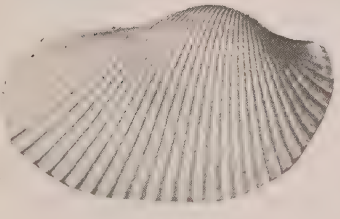

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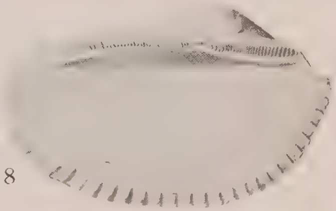

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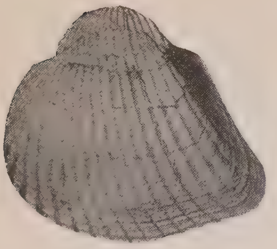
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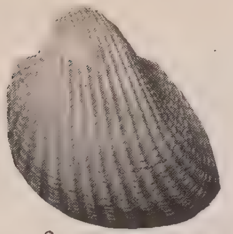
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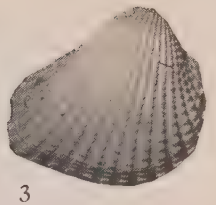
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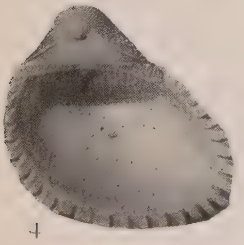
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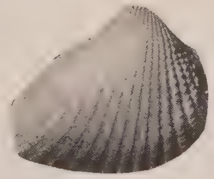
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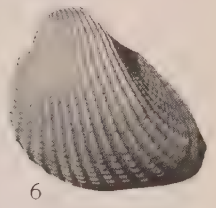
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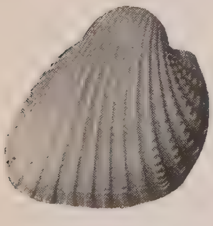
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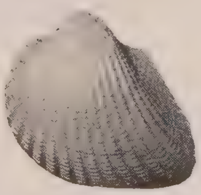
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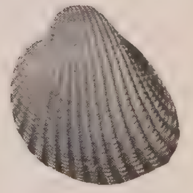
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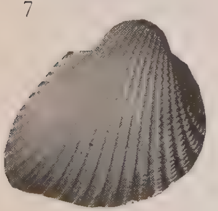
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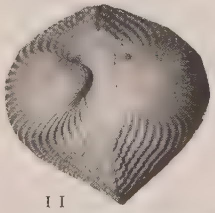
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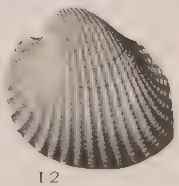
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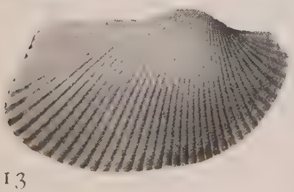
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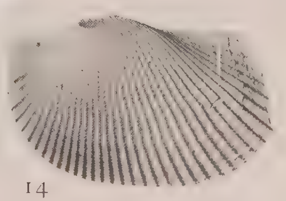
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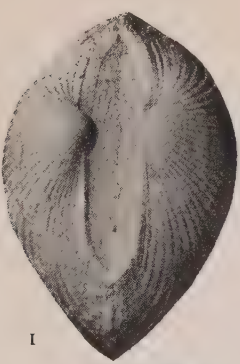

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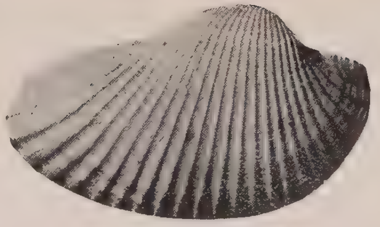

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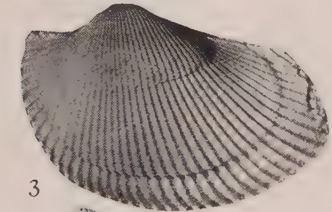

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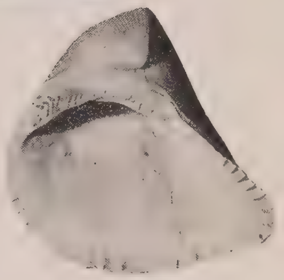

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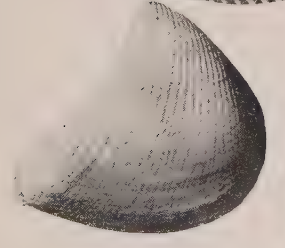

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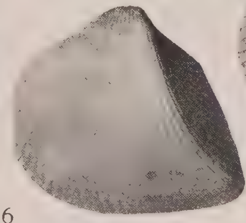

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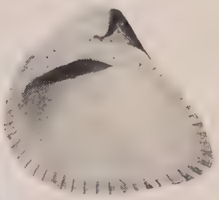

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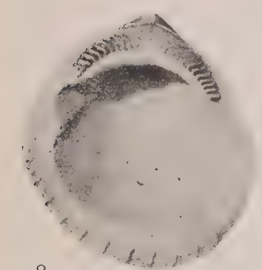

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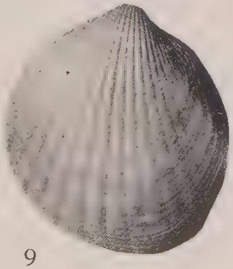

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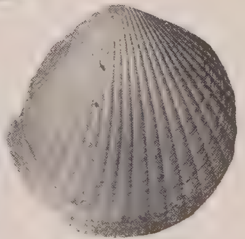

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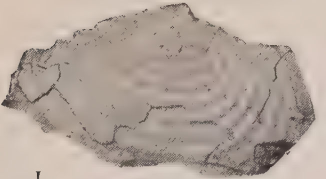
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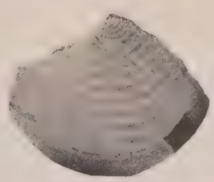
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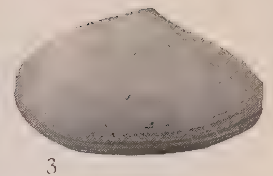
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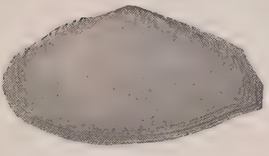
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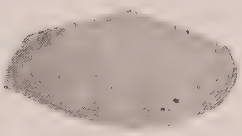
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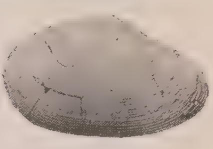
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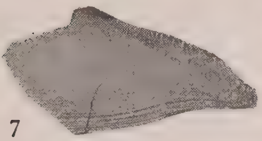
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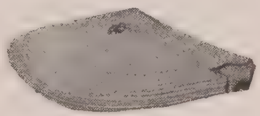
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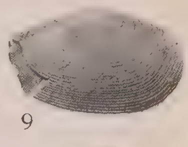
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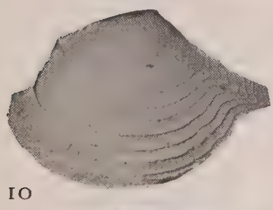
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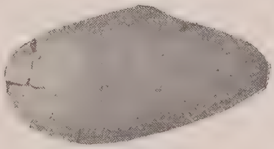
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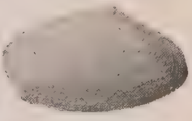
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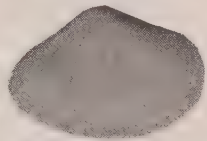
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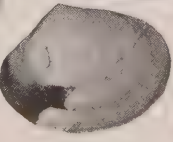
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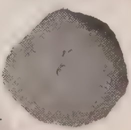
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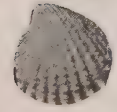
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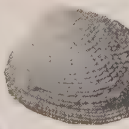
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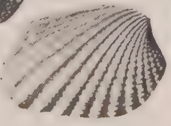
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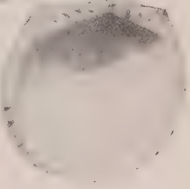
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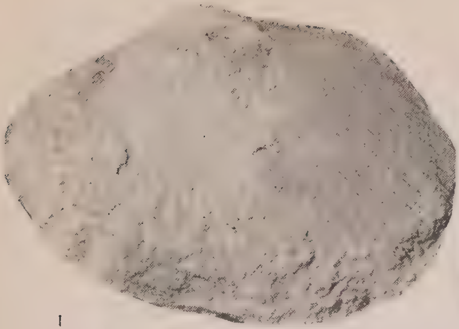
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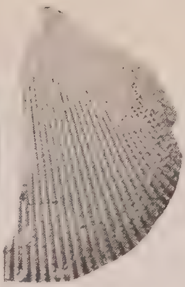
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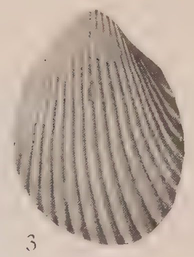
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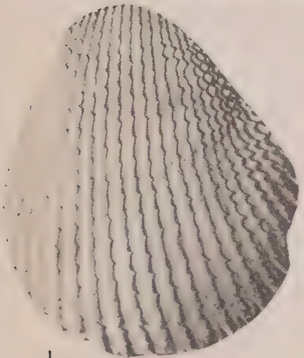
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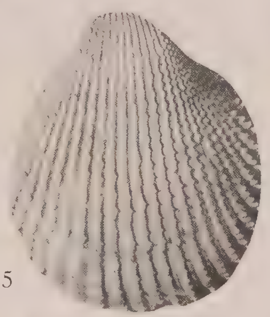
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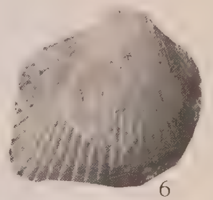
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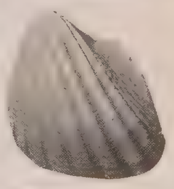
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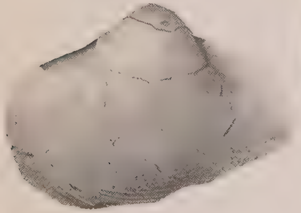
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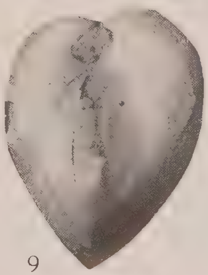
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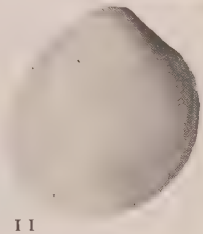
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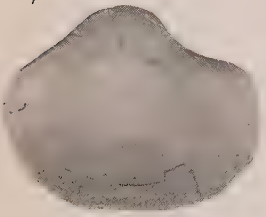
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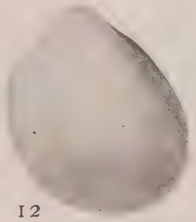
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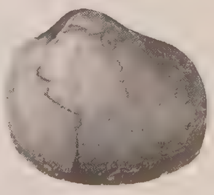
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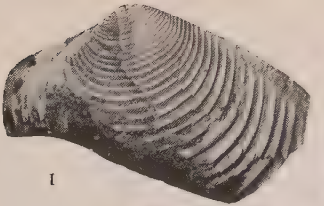
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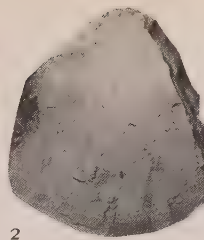
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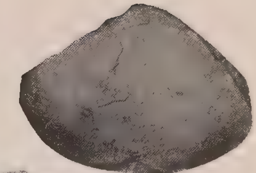
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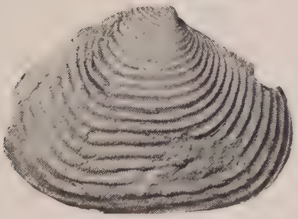
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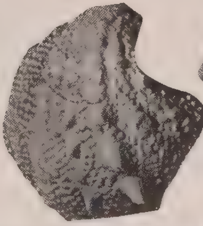
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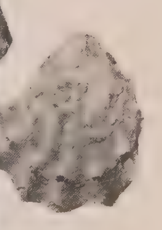
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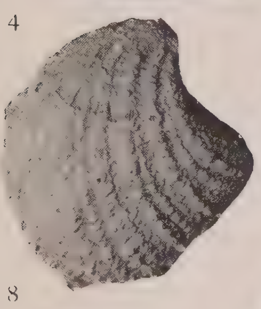
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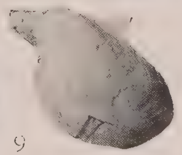
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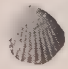
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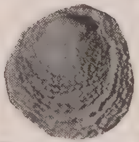
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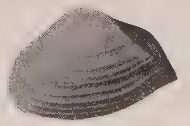
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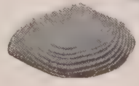
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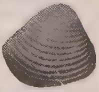
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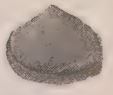
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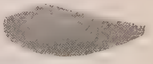
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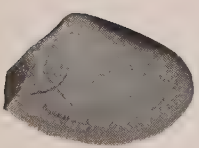
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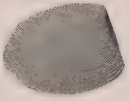
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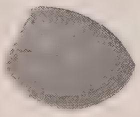
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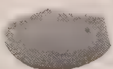
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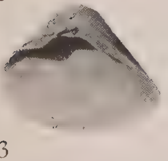
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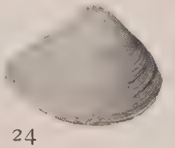
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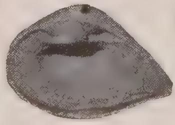
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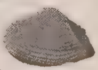
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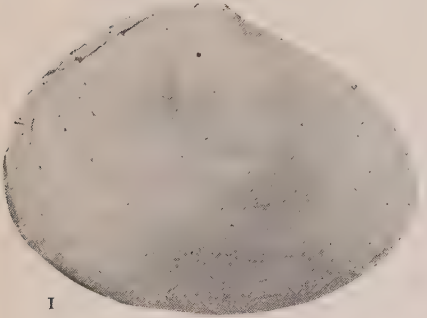
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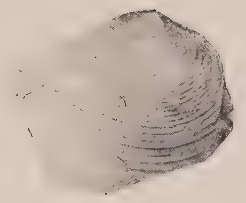
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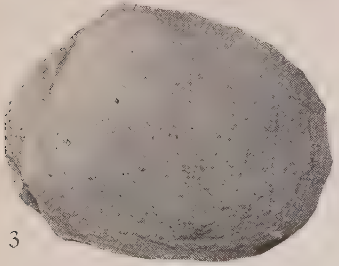
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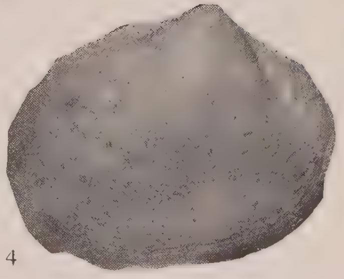
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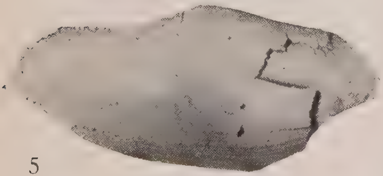
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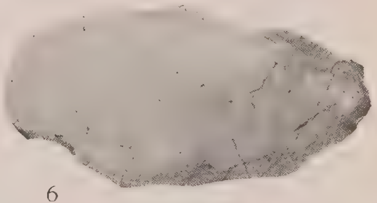
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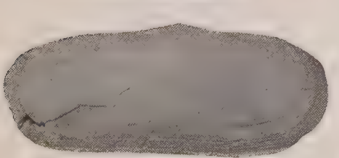
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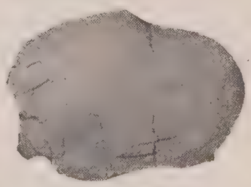
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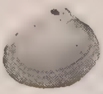
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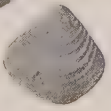
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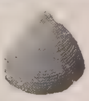
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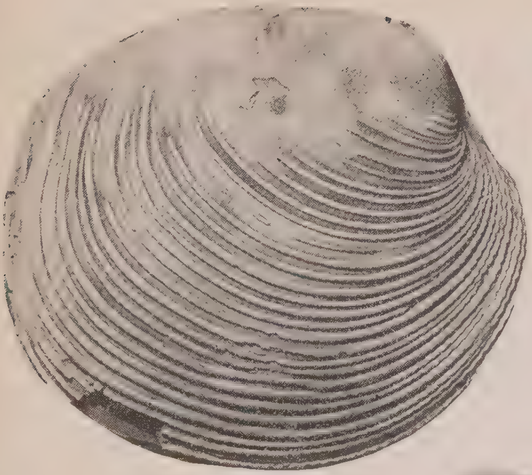

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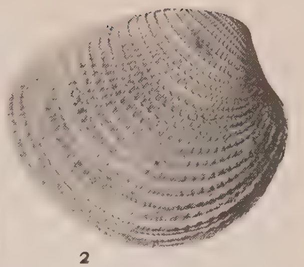

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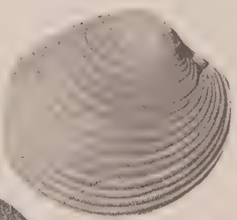

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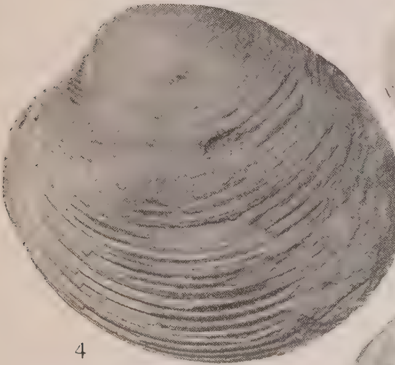

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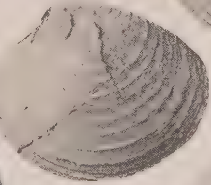

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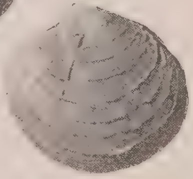

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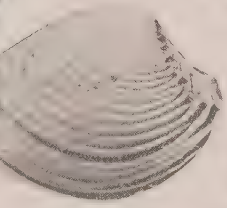

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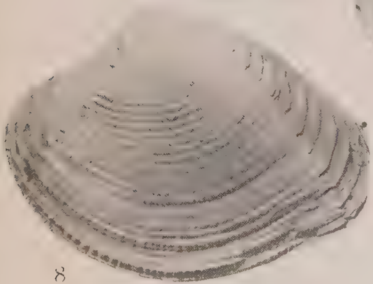

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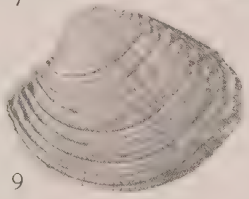

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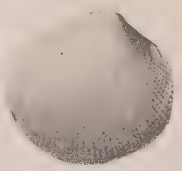

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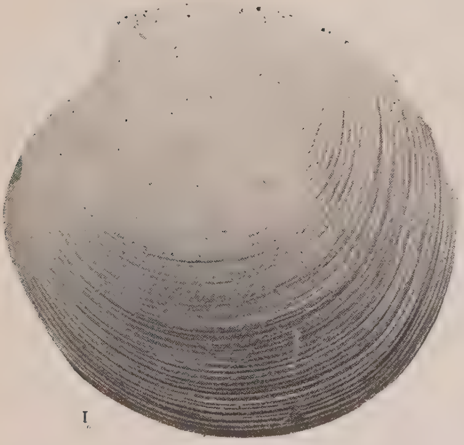
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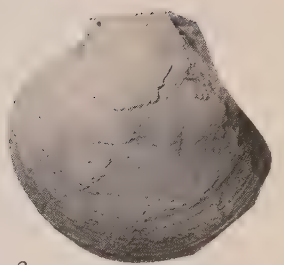
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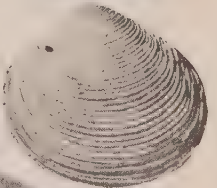
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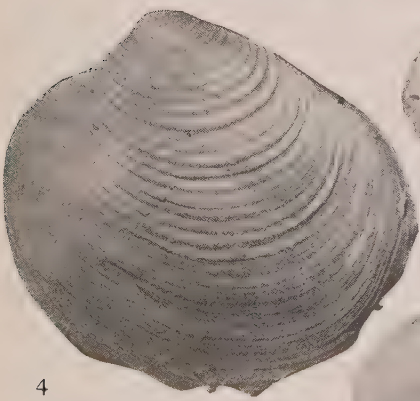
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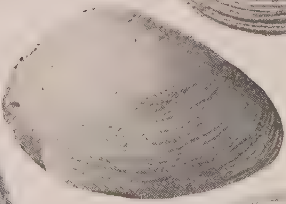
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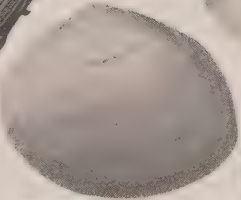
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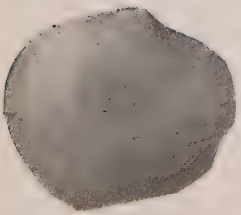
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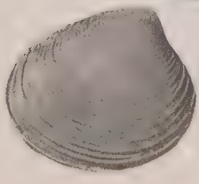
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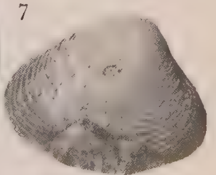
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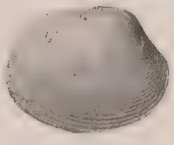
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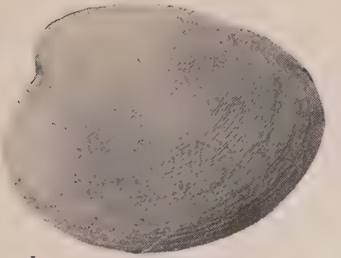
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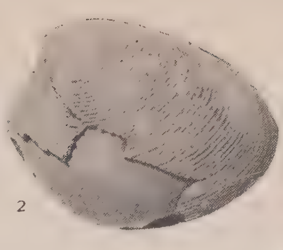
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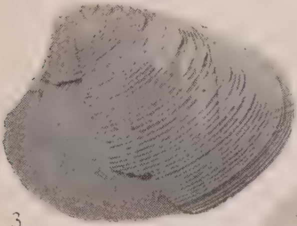
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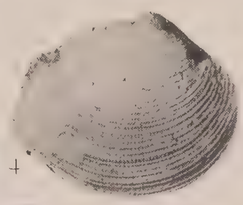
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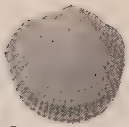
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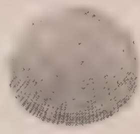
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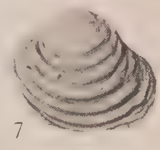
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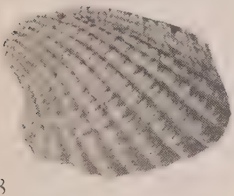
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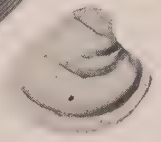
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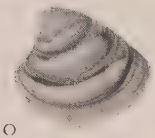
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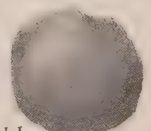
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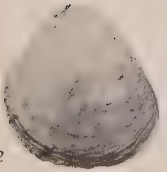
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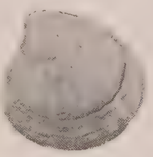
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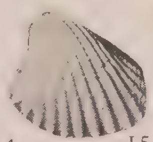
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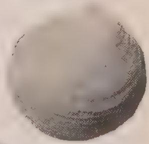
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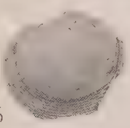
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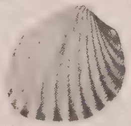
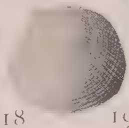
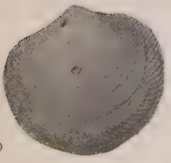

17


18

19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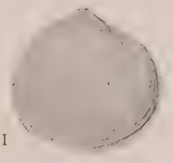
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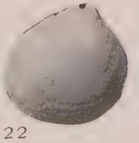
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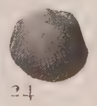
24

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INDEX TO VOLUME 9

Note.—Figures refer to the continuous numbering of the volume (*not of the separate Bulletins*); *Roman numerals refer to pages; Italics, to plates.*

A

Abra triangulata *32*..........200, 431
Acanthochites pygmæus..........170
  spiculosus..........169
Acanthopleura granulata..........169
  picea..........169
Acmæa candeana..........151
  leucopleura..........152
  melanoleuca..........152
  punctulata..........151
Actæon costaricensis *18*..........206a
  cubensis..........45
  delicatus..........46
  exilis..........45
  galvestonesis..........47
  incisus..........46
  nitidus..........46
  perforatus..........46
  punctatus..........45
  punctostriatus..........45
  pusillus..........46
Acteocina bullata..........47, 190, 199
  bullata, var. costaricana *18*..........206a
  canaliculata..........48
  candei..........48
  recta..........47, 190, 194, 191, 206b
  triticum-tritonia..........194
  wetherilii..........48
Adeorbis adamsi..........159
  supranitidus..........160
Admete microscopica..........75
Aesopus stearnsi..........94
Alaba tervaricosa..........138
  turrita..........199, 325
Alabina adamsi..........127
  cerithioides..........128
Alectrion acutus..........89
  alba..........89
  ambiguus..........89
  antillarum..........89
  beaumontensis..........91
  candidissima..........89
  consensus..........90
  fretensis..........89
  galvestonensis..........90
  hotessieri..........90
  losquemodica..........195
  losquemodica *12*..........295
  merenda *12*..........296
  obsoletus..........90
  ranuncula *12*..........295
  trigalvestus..........90
  vibex..........89
Alum Bluff series..........202
Alexia..........57
Amaura tombigbeensis..........26
Amphiperas canadiensis..........112
Ampullaria caliginosa..........141
  depressa..........141
  pinei..........141
Amusium bocasense *20*..........378
  luna..........200
  lyonii..........187
  mortoni..........200, 377
  toulæ..........186
Anachis albella..........93
  amphisella..........92
  avara..........91

avara, var. semiplicata.........92
  var. similis. 91
  var. translirata..................92
  cancellata.........................92
  catenata 92
  fugax......... 186
  hotesseriana.. 93
  obesa..............................92
  ornata 92
  ostreicola...... 92
  pretri...............................93
Ancillaria acquaensis *10*.........266
  chipolana 267
  pinguis 267
  subglobosa.........................7
Ancillopsis tuomeyi *1*..............12
Ancistrobasis.......................158
Ancystosyrinx dalli *7*... 232
  elegans *7*.................190, 232
  radiata...... 63
Anomia ephippium......... 381
  simplex... ....189, 194, 200, 205 *24*.....................381
Antalis.................................35
Antigona blandiana *33*...........431
  harrisiana 188
  harrisiana *33*............. 413
  multicostata *33*.........189, 191 411
  rugosa *33*.................189, 412
  tarquinia *33*......196, 194, 412
Aphera islacolonis zone...........193
Aplysia........................... 53
Arca actinophora *26*..............357
  auriculata *25*......189, 193, 199 362
  cacica *27*.........................362
  candida *25*.................189, 355
  chiriquiensis......................193
  consobrina. 358
  costaricensis *28*.................358
  dariensis *25*..............187, 356
  gatuneasis.........................356
  golfoyaquensis....................193
  golfoyaquensis, var. medioamericana *26* 360
  grandis............................191
  henekeni *27*........193, 196, 358
  hindsi *27*..... 365
  honensis *25*.....................359
  imbricata.. 354
  lloydi *27*..........................364
  macdonaldi *28*...187, 191, 366
  mauryæ *25*.................354, 193
  occidentalis *25*..........189, 193 199, 353
  oronlensis 356
  ozarkensis *3*......................22
  patricia............ 191
  pittieri *27* 187, 364
  reversa....................... ... 191
  sobrina............................358
  umbonata *25*.....189, 193, 354
  veatchi *26*........................361
Architectonica granulata *19*...138 190, 191, 196, 200, 326
  perspectiva................138, 326
Aspella, var. obeliscus.............117
  var. paupercula..... 117
  scalarioides.......................117
Assiminea auberiana,...............142
Astralium brevispinum *18*......190 334
  cælatum.....................190, 334
Astyris diaphana 94
  duclosiana.. 94
  lunata..................... 93
Atlanta peroni......................111
Atys robustoides............. 26
Auricula corona.......................56
  ovula.................................55
  pellucens........... 54
Auriculina insculpta 46

Auriculastrum..........................54
Aurinia dubia..........................82
mutabilis.......................... 81
robusta...........................81
Avicula inornata.................. 367

B

Balanophylla haleana................27
Balantium 43
Barnea alatoidea........... 7
Basilissa alta................. 157
costulata..........................158
superba.............................158
var. delicatula 158
var. depressa.. 158
Basterotia ? prima *3*...............20
Bathoxyphus........ 38
Bela filifera.......... 68
Benthodolium...........................117
Benthonella fischeri..................140
gaza..................................140
nisonis.......... 140
Bittium boiplex..................... 128
cerithioide................. 128
galvestonense...... 129
gibberulum 128
nigrum............ 128
nugatorium........................186
varium......... 128
yucatecanum.. 135
Bivonia exerta.......................132
Blauneria...............................56
heteroclita................. 57
pellucida 57
Boreotrophon...........................99
Borsonia cocoensis *8*.............250
Bothrocorbula viminea............442
Bowden beds, Jamaica............199
Buccinum obesum.....................92
orbingyi 87
patula 99
zonalis..............................94
Bulimus monile.........................55
Bulla........................ ....48, 49
biblicata.............................50
canaliculata.......................47
paupercnla 206d
recta........................... 206a
Bullaria abyssicola.. 51
amygdala.........................206d
occidentalis.......................50
pauperculia *7*...194, 199, 206c
pinguiscula.................. 51
solida.................................51
striata 50
Bursa affinis............................114
crassa *18*.....190, 195, 200, 306
Busycon canaliculatum 85
carica.......... 86
eliceans.......................... 86
perversum 86
pyrum..............................85

C

Cadulus arctus....................... 41
amiantus 40
carolinensis.......................40
elongatus.........................40
mayori.................... 41
parvus...... 40
poculum... 40
quadridentatus....................40
transitorius........................41
turgidus.............................26
Cæcum annulatum..................130
bipartitum.........................130
carolinanum......................130
costatum..........................131
glabrum 131
instructum........................130
irregulare..........................130
nitidum 132
pulchellum........................131

  floridanum........................130
Calliostoma asperrimum...........156
  castilla *18*......................337
  circumcinctum.... 154
  corbis 155
  euglyptus.........................154
  jujubinum.........................155
  limonensis *18*..................336
  mancinella *18*..................336
  pulcherum.........................155
  var. rawsoni.......... 156
  roseolum 155
  tampænsis... 165
  tiara..................................155
  veliei.................................155
  yucatecanum......................156
Callocardia gatunensis *35*.......407
Callogaza............................154
Calyptræa candeana 145
  parvulus............................145
Calyptraphorus valatus, var. compressus.......... 26
Cancellaria agassizi..................74
  alveata.................................7
  barretti *9*..................200, 253
  bullata.................................191
  candei................ 88
  clavatula 74
  conradiana...........................74
  cossmanni *9*.......................253
  costata..................................7
  dariena *9*...........................252
  epistomifera...............195, 255
  galvestonensis......................74
  gilberti *1*................. 13
  islacolonis *9*. 187, 191, 195
    196, 258
  mauryæ *9*..................195, 254
  moorei... 255
  panones 7
  plummeri *9*......... .....191, 257
  reticulata.............................74
  rowelli *9*...................195, 256
  simpsoni................ 75
  tenera 74
  tessellata..................191, 258
  toroensis *9*...............191, 256
  var. trachyostraca..............252
  tuberculata.. 191
Cantharus limbatus..................88
  orbignyi..............................87
  tinctus... 87
Capulus intortus......... 143
Cardata caribbeanensis *29*......386
  laticostata 387
  matima *35*..... 387
  scarbricostata.....................388
Cardium, var. alternata............189
  apateticum..........................399
  costaricanum *30*..... 398
  dominicense *30*.........194, 397
  durum................................186
  gatunense.................186, 397
  heredium *30*............ 399
  medium *30*...189, 194, 205, 398
  serratum *30*........194, 205, 400
  spinosum,.................189, 205
  var. turtoni *30*.................400
  striatum *30*...............188, 397
  sublineatum 201
Careliopsis...........................110
Caricella dolita.........................7
Caryatis guppyana........ 409
Cassidaria lævigata..................308
Cassis cameo..........................118
  flammea.............................307
  inflata...............................118
  monilifera..........................307
  reclusa..............................307
  sulcifera.............195, 200, 306
  testiculus..........................118
  tuberosa............................118

Cavolina inflexa 42
  trispinosa 42
  uncinata 42
Cercado formation 193
Cerithidea costata 126
  hegewishi 127
  scalariformis 126
  turrita 126
  varicosa 126
Cerithiopsis burkvillensis 123
  crystallina 123
  emersoni 124
  estellensis *2* 15
  greenei 123
  martensi 123
  subulata 124
  vanhyningi 123
Cerithium algicola 125
  costaricense *13* 315
  dislocatum 59
  eburneum 125
  floridanum 124
  galvestonense 126
  greenei 123
  litteratum 125
  minimum 125
  var. nigrescens 125
  muscarum 125
  protextum 59
  punctatum 124
  terebralis 124
  variabile 125
Chætopleura apiculata 168
Chama antiquata 390
  arcinella 391
  congregata *31* 203, 390
  congregatoides 390
Cheilea equestris 143
  prinectonia 186
Chemnitzia 108
Chesapeake Miocene 202
Chione chiriquiensis *35* 420
  costaricensis *35* 417
  grus *29* 189, 205, 420
  holocyma *33* 419
  hotelensis *35* 419
  mactropsis *33* 188, 417
  rowleei *33* 188, 416
  tegulum 187
  ulocyma 200, 201, 417
Chiton 168
  marmoratus 169
  tuberculatus 169
Chicoreus 95
Chlorostoma costaricensis *18* 335
Choristella pompholyx 161
Circulus liratus 160
  trilix 160
Clathurella jewetti 70
Clava alajuela *13* 317
  chipolana 126
  costaricana *13* 316
Clementia dariena *34* 187, 404
Cleodora lanceolata 42
Clio recurva 43
  pyramidata 42
Cochliolepis parasitica 159
  striata 159
Columbella ambigua 298
  mercatoria 93
  rusticoides 93
  submercatoris *13* 297
Columbraria testacea 115
Compressidens 39
Conomitra 82
Conus æmulator 186
  agassizi 200, 226
  amphiurgus 62
  berghausi 215
  var. boscensis *6* 223
  burckharti *6* 200, 224
  catenatus 215
  centurio 61

Conus chipolanus... ....62, 217
  concavitectum..................215
  consobrinus ... .186, 195
  var. costaricensis *6*..........217
  dalli..............................217
  delessertianus....................61
  demiurgus.........................216
  domingensis........ ......186, 195
  flavescens.. 61
  floridanua..................61, 189
  gaza 226
  gracilissimus *4*...195, 199, 224
  granozonatus *6*.........199, 222
  harrisi *6*..... 225
  haytensis............ .....186, 194
  imitator *5*.......................217
  interstinctus *6*.........199, 220
  leonensis 215
  leoninus............................61
  limonensis *8*...........188, 219
  marginatus *4*...........195, 223
  molis *5*...................188, 214
  var. multiliratus.................200
  multiliratus...............195, 201
  multistriatus *4*................226
  musaensis *5*....................219
  peali 62
  planiliratus *6*.....188, 199, 222
  proteus *5*......61, 189, 195, 215
  pygmæus............................62
  pyriformis.................191, 218
  recognitus *5*......191, 195, 199
  218
  regularis................ 222
  sewalli.....................194, 220
  solidus.............................218
  stearnsi.............................62
  stenostomus *8*....188, 195, 199
  214
  toroensis *5*.... 220
  tortuosopunctatus *6*........ 226
  tortuosostriatus *4*............221
  veatchi *5*........................216
Coralliophila abbreviata..........101
  deburghiæ.... . .. .101
  lactuca....................... 101
Corbula dietziana *24*. 189, 440
  disparilis.... 438
  gatunensis....... 186
  hexacyma *24*...........441, 442
  milium 25
  oropendula *31*.................439
  orosi *24*..........................441
  sericea....... 186
  sphenis............................186
  subcompressa......................25
  vieta *31*............. ......194, 438
  viminea *31*...194, 196, 200, 442
Costa Rican Geosyncline 205
Costa Rica Stratigraphy...........181
Cranopsis.............. 167
Crassatella antillarum..............384
Crassatellites bowdeninsis, var.
  costaricensis *32*............ .385
  gabbi....................... 25
  mediensis *32*....................385
  mediamericanus. 384
  reevei *23*.........................384
  sepulcollis..........................25
Cremides...............................16
Crepidula aculeata. 144
  convexa 144
  fornicata...........................143
  plana...........144, 190, 199, 331
Crepitacella limonensis *18*......315
Creseis subula..........................43
Crucibulum auricula.................145
  planatum...................... .145
  scutillatum.........................145
  striatum.............................145
Cryptonatica.........................147
Cucullæa macrodonta.. 25
  saffordi...............................25

- Cuvierina columnella..........44
- Cyathodonta gatunensis..........383
- Cyclostrema affine..........161
  - pompholyx..........161
  - regulosum..........160
  - trochoides..........161
- Cylichna bidentata..........205c
  - deKayi..........7
  - meyeri..........26
- Cyclinella beteyensis *34*...191, 414
  - gatunensis..........187
  - kroyeri..........191
  - subquadrata..........191
  - var. quitana *34*..........415
- Cylichnella bidentata..........50
  - var. galvestonensis..........50
  - triticum-tritonis..........206c
- Cylindrobulla beaui..........52
- Cymatium chlorostomum..........116
  - cynocephalum..........116
  - gracile..........116
  - olearium..........116
- Cymatosyrinx centimata..........67
  - moseri..........67
- Cyphoma gibbosa..........112
- Cypræa alminatensis *15*..........312
  - cinerea *15*..........113, 312
  - dominicensis..........196, 312
  - estellensis *2*..........14
  - exanthema..........113
  - henekeni..........186, 196
  - parisimina *15*..........311
  - smithi..........15
  - spurca..........113
- Cypræcassis..........118
- Cythara heptagona..........186, 195
  - terminula, var. costaricensis *8*..........249
- Cytharella cymella..........73
  - galvestonensis..........73
  - limata *8*..........249
- Cytherea alternata..........408
  - blandiana..........200
  - dariena..........406
  - juncea..........408
  - tarquina..........412

D

- Daphnella hormophora..........73
  - leucophlegma..........73
  - limacina..........73
- Defrancia chyta..........72
  - perpauxilla..........72
- Dentalium antillarum..........35, 36
  - bartletti..........36
  - bocasensis *18*..........338
  - callipeplum..........37
  - callithrix..........36
  - ceras..........36
  - ceratum..........35
  - compressum..........39
  - didymum..........39
  - disparile..........35
  - eboreum..........37
  - ensiculus..........38
  - filum..........38
  - floridense..........339
  - gouldii..........34
  - laqueatum..........34
  - leptum..........37
  - matara..........37
  - mediaviaense..........26
  - meridionale..........36
  - ophiodon..........39
  - perlongum..........38
  - pressum..........39
  - pseudohexagonum..........35
  - quadrangulare..........39
  - rebeccaensis..........34
  - semistriolatum..........37
  - sericatum..........37
  - sexangulare..........34

Dentalium sowerbyi..................38
var. pelliceri......................38
taphrium........ 35
tetragonum........................39
texasianum........................34
var. cestum 34
uscarianum *18*..........187, 338
Dentistyla........................ 156
Detracia...............................56
Diacria...................................42
Diplodonta collina *35*...........392
insula *35*.......................392
nana...... 7
Distortio, var. clathratus.........115
gastunensis 306
reticulatus............ 115
simillima 195
Distortrix. 115
simillima........ 305
Divaricella quadrisulcata *35*...189
200, 205, 396
Dolium................. 119
camura 196
elliptica............................196
ellipticum. 311
Donax acutangula *3* 22
Dosinia acetabulum *34*.....118, 201
203, 403
delicatissima....................187
Drillia acestra................ 65
albicoma...........................64
albinodata..........................65
alesidota, var. macilenta......64
aquænsis *8*.........................245
aquanica *8*...... 237
aurantia *8*.. 240
bandella.............................72
bocatoroensis *8*..............239
boscensis *8* 245
var. carminura...................66
carruca *7*..........................243
chiriquiensis *8*.................236
chyta................... 72
circumvoluta.................. .64
citria *8*............... 237
coccos *8*.......... 236
cocosina *8*................. 247
comatotropis...................... .72
consors *7*....195, 199, 200, 233
cristobali *8* 244
dalli, var. cestrota..............66
detecta 64
ebur....................................65
eluciva 72
enneacyma 186
estrellana *14*.....................241
exasperata......... 65
exsculpa.............................73
eucosmia, var. canna..........64
fusiformis..........................238
fusinus.............................186
gatunensis........................186
haliostrephis..............65, 235
havanensis.........................67
ipara...................................73
leucomya 64
limonensis *8*....................243
limonetta *8*......................242
limoncia *7*........................238
lissotropis..........................66
lithocollecta......................67
lithocollectoides *8*...........246
lonsdalli..... 7
moensis 235
musa *8*...........................246
musacina *8*......................241
nucleata 66
ostrearum................. 64
pagodula 65
papaya *7*................. 235

Drillia pelagia..........72
  peripla..........71
  pharcida..........65
  simpsoni..........66
  subsida..........73
  thea..........66
  theobroma *8*..........240
  tiara..........72
  tristicha..........65
  vaningeni..........186
  venusta *7*..........195, 200, 233
  verrilli..........66
  zooki..........186

E

Echinella nodulosa..........137
Echinochama antiquata *31*..199, 390
  trachyderma..........391
  yaquensis *31*..........194, 391
  meyeri *3*.......... 24
Egerella subtrigonia..........7
Emarginula compressa..........167
  frenulata..........167
Embolus inflatus..........44
Epicynia multicarinata..........161
Episiphon..........38
Epitonium angulatum..........101
  clathrum..........102
  cochlea..........103
  contorquatum..........104
  denticulatum..........102
  galvestonense..........103
  lineatum..........102
  mitchelli..........103
  modestum..........104
  multiliniferum *1*..........11
  multistriatum..........104
  munistriatum *1*..........10
  nitidellum..........102
  sayanum..........102
  scipio..........102
  sericifila..........103
  subacutum *1*..........11
  tenue..........102
  turriculum..........103
Erato lævis..........114
  maugeria..........114
Ervilia lignitica *3*..........21
  polita..........22
Ethalia reclusa..........162
  solida..........162
  suppressa..........162
Eubala..........73
Eulima..........105
Eulimella unifasciata..........107
Eumeta..........124
Eunaticina semisulcata..........151
Eupleura caudata..........99
    var. sulcidentata..........99
  muriciformis..........99
Euspira..........147
Eutrochus..........155
Exilia pergracilis..........7, 27

F

Fasciolaria distans..........83
  gigantea.......... 83
  gorgasiana *11*..........277
  macdonaldi *11*.......... 278
  meekiana..........84
  tulipa *16*..........83, 205, 277
Favartia cellulosa..........96
    var. levicula..........97
  intermedia..........97
  nuceus..........96
Fissidentalium..........36
Fissurella alternata..........166
  asturiana..........167
  barbadensis..........165
Fissurellidea fasciata..........165
Fissuridea alternata..........166
  cayenensis..........
Fissurisepta..........167
Flabellum conoideum..........27
Fusinus æpynotus..........85
  alcimus..........84
  amiantus..........84
  amphiurgus..........85

  - couei........ 84
  - eucosmius....... 84
  - timessus 84
  - honensis *11*......................276
  - miocosmius *11*.......... 275
  - mohri......................... 26
  - ottonis...... 26
  - quercollis............................26
  - tesellatus.. 81
  - tortilis...............................26

G

- Gadila 41
- Gafrarium altum, var. costaricense *35*............ 406
  - limonense *35*............188, 405
- Gastrochæna ovata...... 438
  - rotunda.....................200, 438
- Gatun stage................ .....181, 162
- Gaza fischeri 153
  - superba...........................153
  - watsoni.......................... 154
- Genota didyma........... 63
  - mitrella......................... 63
- Gilbertia estellensis *2*.........13, 26
- Glycymeris aviculoides.... 25
  - canalis *21*..........................349
  - carbasina *22* 351
  - castaneus *21*..............189, 352
  - decussatus *22*......................352
- Glycymeris decussatus.......... .189
  - jamaicensis *22*...194, 196, 199 350
  - lloydsmithi *28*......................352
  - trilobicostatus....................349
- Glyphostoma dentifera 195, 190, 248
  - gabbi... 69
  - gratula... 69
  - moinica *8*... 248
- Graptacme. 37
- Gratelupia mactropsis..............417
- Gurabo formation........................193
- Gyrineum 115

H

- Halia americana *7*.................251
- Haminæa antillarum.................52
  - antillarum, var guadalupensis.......................... 52
  - elegans............................ 51
  - guildingi.............................51
  - petiti...................................52
  - succinea..............................52
  - virescens 52
- Haustator...............................134
- Helix depressus.......................141
- Heteroschisma........................36
- Hydatina physis................ 53

I

- Infundibulum..........................145
- Isapis ebsoleta.........................137
- Ischnochiton limaciformis........168
  - papillosus 169
  - puruprascens 168

J

- Jaminia 110
- Janthina communis 104
  - fragilis 104
  - globosa........... 104
  - janthina............................104
  - pallida 104

L

- Labiosa lineata *25*.....189, 205, 436
- Lævibuccinum harrisi *2*...........16
- Lævicardium serratum 200
  - sublineatum.......................200
- Lævidentalium.........................37
- Lamellaria rangi.....................151
- Lampusia.................................116
- Latiaxis..................... 101
- Latirus infundibulum *11*...190, 195 200, 279

Latirus irazu *11*....279
taurua *11*....280
Leba balboæ *21*....345
dalliana *31*....347
Leda davilæ *21*....345
ensinoides *21*....346
milamensis....25
parva....25
quercollis....25
quitanensis *21*....346
saffordana....25
Lepella tubicola....152
Lepidopleurus pergranatus....168
Leptochiton....168
Leptothyra induta....153
Leuconia....56
Leucosyrinx chloris *8*....231
sigsbeei....63
subgrundifera....63
tenoceras....63
verrilli....62
Leucozonia cingulifera....85
ocellata....85
Levifusus dalei....26
pagoda....26
suteri....7
Limæa solida....194
Limopsis monilis *29*....349
Linæa solida *31*....199, 381
Liostraca....106
Liotia bairdi....154
gemmia....154
tricarinata....154
Lissospira proxima....160
Litiopa bombix....137
melaniostoma....137
Littorina augulifera....136
irrorata....136
mespilum....136
tectarius....137
ziczac....136
Livona pica....153
Longchæus....107
Lotorium....117
Lucapina adspersa....165
cancellata....165
fasciata....165
hondurasensis....165
suffusa....165
Lucina cristata....426
divaricata....396
primoidea *2*....19
quadrisulcata....200
Lunatia....148

M

Mocoma costaricana *29*....428
elongata....191
gatunensis *29*....429
panamensis....101
var. canalis *29*....429
Macrocallista maculata *34*....189, 406
Mactra alata *31*....189, 194, 435
elegans....191
estrellana *31*....191, 435
exoleta *31*....189, 191, 434
nuttalli....437
sincola *31*....436
Malea camura....186, 191, 200
elliptica *15*....311
ringens....191
Mammilla....149
Mangilia antonia....71
astrictia....69
atrostyla....70
balteata....69
biconica....69
cerina....70
cerinella....71
limonitella....70
melanitica....71
peripla....71
plicosa....69

    quadrata..........71
    rubella..........70
    stellata..........70
Mao Clay..........193
Margarita filosa..........154
Marginella apicina..........77
    aureocincta..........79
    avena *10*......80, 188, 190, 269
    carnea..........77
    cassis..........77
    collina *10*..........269
    coniformis..........268
    conoidalis.......... 78
    denticulata..........78
    fusina..........79
    gutanensis..........186
    hadria.......... 80
    lacrimula..........81
    latissima..........268
    leander *9*..........270
    macdonaldi *9*..........187, 267
    mindiensis *9*..........268
    minima..........79
    minuta..........79
    musacina *13*..........270
    oblonga..........80
    opalina..........78
    ovuliformis..........80
    pellucida..........78
        var. pilsbryi *13*..........268
    rostrata..........80
    seminula..........80
    storeria..........77
    succinea..........79
    virginiana..........78
    watsoni..........78
    yucatecana..........80
Marsenina ampla..........151
Martesia recurva *2*..........19
Mathilda yucatecana..........135
Meioceras deshayesi..........131
    nitidum..........132
    undulosum..........132

Melampus bidentatus..........55
    biplicatus..........56
    bulloides..........56
    cironulus..........55
    coffeus..........54
        var. gundlachi..........55
    coniformis..........54
    corenatus..........55
    crosseana..........56
    flavus..........55
    floridanus..........55
    hemphilli..........56
    jaumei..........56
    lineatus..........55
    torosa..........55
Melanella bilineata..........106
    conoidea..........105
    fusus..........106
    gibba..........105
    gracilis..........105
    hemphilli..........106
    intermedia..........105
    jamaicensis..........105
    subcarinata..........105
Melongena consors *12*...195, 200, 284
    corona..........86
    melongena..........87, 200, 284
Meretrix dariena..........404
    ripleyana..........25
Mesalia alabamiensis..........26
    pumila..........26
    watsonensis..........26
Mesodesma costaricensis *31*.....437
Mesorhytis..........84
Metis barba *32*..........427
Metula cancellata *13*......195, 200, 287
    gabbi *13*..........287
    harrisi *13*..........288
        var. limonensis *13*......288
Mexican Miocene..........200
Microdrillia rostratula..........7

Mitra alamagrensis............188, 275
blakeana 82
var. coralliophila *9*..........273
dariensis *9*. 273
gemmata 82
var. limonensis.................191
longa *9* 195, 273
poas *9*....................188, 274
rudis *9*...... .... 195, 274
straminea........ 82
styria 82
swainsoni 191
swainsoni, var. limonensis
9..................................272
wandoensis 82
Mitromorpha pygmæa......... 82
turriculata..........................51
Modulus floridanus..................129
modulus............. 129
saffordi...............................25
Montacuta bicuspidata *2*..........20
herberti *3* 21
Mulinia lateralis, var. sauryensis *31*.......................438
Muricidea hemhilli 98
Muricidea hexagona...................98
multangula............................98
ostrearum.......................... 98
philippiana 98
Murex asperrimus.............. 96
beaui.......... .... .95
brevifrons........... 96
cabriti................ 95
cellulosa....... 96
cornurectus...............195, 303
fulvescens...........................96
gatunensis.... 186
globosa................................96
messorius.. ....95, 190, 195, 303
oculatus...............................96
polynematicus 186
pomum................................96
rufus..................................95
Myrtæa limoniana *35*......200, 393

N

Nassa beaumontensis.................91
hotessieri...........................90
obsoleta...............................90
pleona *1*..............................12
Nassarina bushi........................89
columbellata.........................88
grayi...... 88
Natica alticallosa......................147
bolus....................................186
canalizonalis........ 186
canrena *16*..147, 190, 196, 199, 327
eminula 26
fordiana.............................151
guppyana *16*.............188, 328
jamaicensis.........................146
lactea 149
livida....................................146
limula....................................26
maroccana.............................146
onusta....................................26
plicatella...............................146
proxima.... 146
pusilla....................................147
reversa....................................26
saffordia ? 26
subclausa...............................329
sulcata 328
youngi 196
youngi, var. cocleana *16* 327
Naticina lactea..........................149
Neosimnia................................112
Nerita peloronta.......................162
tessellata..............................162
versicolor............ 163
Neritina pupa...........................164
reclivata...............................163
showalteri.............................164
sparsilineata.........................164
virginea 165

viridemaris *18*..........196, 331
viridis..............................164
Neverita brunnea 150
campechiensis 149
duplicata.........................148
glauca..............................191
mamillaris........................150
nereidis........187, 191, 196, 330
nubila..............................149
texasiana..........................149
uberina............................149
Niso æglees..........................106
splendidula.......................106
Nitidella parvula........................94
Norona......................................74
Northia northiæ...............190, 191
northiæ, var. miocenica
12..............................296
Nucula cahuitensis *21*............343
isthmica..........................186
mediavia 25
orbicella *31*...................... 343
ovula..................................25
tenuisculpta *21*.........193, 344
Nyctilochus femorale................116

O

Obeliscus tesellatus..................107
Ocinebra................................ 117
Odostomia acutidens 110
bartschi *1*...........................8
conoidea. 110
impressa...........................110
seminuda..........................110
Oligocene, Costa Rica..............181
Oliva brevispira *10*.........195, 260
carolinensis..........................75
circinata..............................75
cylidrica *10*.......195, 200, 260
Oliva gatunensis *10*................261
giraudi 261
liodes 75
litterata.....................................75
mancinella *10*..................263
reticularis 260
sayana, var. immortua *10*
205, 261
testica, var. costaricensia
10 190, 262
testacea 191, 192
Olivella, var. bocasensis *10*.....266
boussaci *10*.........................265
eutacta 77
floralia 76
galvestonensis 77
goliath *10* 264
jaspidea...............................76
limonensis *10*............188, 265
mediavia 26
mutica..................................76
muticoides *10*...........195, 264
nivea...................................76
pusilla..................................76
semilignitica *1*...................13
subtexana 77
testacea..............................192
Oniscia......................................118
Oniscidia dennisoni....................118
Oocorys abyssorum....................117
Ostrea costaricensis *24*...201,
368
gatunensis..........................186
intermedoides *3*...................23
megodon *21*......189, 191,
194, 199, 367
sculpturata 201
Ovula regularoidea *1*...............14
Ovulum 112
antillarum..........................112
arcuatum...........................112
carolinensis........................112
subrostratum......................112

Oxygyrus keraudreni..............111

P

Pachycheilus anagrammatus.....129
satillensis........................ 130
suavis 130
Paludestrina aldrichi........... ..141
auberiana......... 142
cingulata..........................141
milium.. 142
plana................................141
turricula............................142
Panopea bellsensis *3*..............22
Parthenia..............................110
Pasithea guttula....................... 7
Patella........................... 58, 151
equestris............................143
fornicata............................143
Payraudeautia 149
Pecten alabamensis...................25
almirantensis *21*....... 375
aotus *21*................. 376
coralliphila *20*..........188, 371
costaricensis *21*..............373
effosa.............. 186
gatunensis *19*..................369
levicostatus *19*...187, 200, 371
luna *20*.........................377
macdonaldi *19*.................370
oligolepis....... 375
operculariformis 186
preglyptus *20*..................374
reliquus............................186
santarosanus.............200, 371
ventricosus........................192
Pectunculus castaneus.............352
decussatus.................350, 352
pennaceus 350, 352
Pedicularia albida....................113
decussata..........................113
Pedipes elongatus.................... 54
mirabilis........ 54
naticoides.. 54
ovalis....................................54
quadridens............................54
tridens 54
Peracle reticulata............ 44
Peristernia insula *11*..............282
tortugera *11*.. 282
Peristichia agria..................... 111
toreta 111
Persona simillima.............. 305
Petaloconchus domingensis 204, 318
erectus..............................133
irregularis...........................133
sculpturatus *17*...196, 199, 203, 204, 318
varians 133
Petricola millestriata.. 187
Petrotrochus.............................164
Phacoides actinus *35*.......200, 396
bocasensis *35*..................395
costaricensis *35*........ 394
var. medioamericanus........189
radians.....................189, 205
radians, var. medioamericanus *35*. 393
trisulcatus..........189, 205, 394
moniliferum *15*.........200, 307
Phasianella...... 136
brevis 152
mollis........ 333
pulchella.............................152
punctata........... 333
Philine flexuosa.............. 53
Phorus agglutinans.................332
Phos antillarum 88
beteyensis *12*....................294
candei........... 88
elegans............................188
elegans, var. limonensis *12*.............................291
estrellensis *12*.................292
galvestonensis 88
gatunensis *12*...................289
grateloupensis.....................88

  intricatus..........................88
  meruloides *12*..................294
  mexicanus *12*.....200, 201, 289
  Moorei, var. costaricensis
      12 290
  parvus................................88
  subsemicostatus *12*..........293
  veatchi *12*........................293
Phyllonotus...............................96
Pitaria boucaryensis *34*..........411
  circinata *34*........191, 194, 408
  cora....................................187
  guppyana *34*....................409
  hilli, var. musacina *34*.....409
  planivieta..........................409
  vanwinkleæ *35*.................410
Placunanomia lithobleta *24*...194,
      199, 382
Planorbis ophis..........................56
Platyschides...............................40
Pleurotoma 63
  adeona 26
  albida 230
  alesidota..................209, 234
  amblia.................................66
  antillarum.........................230
  barretti..............................230
  blakeana 68
      var. brunnea.................70
  cerina..................................70
  consors..............................234
  gardneri *1* 8
  gratula 69
  haitensis...........................230
  heilprini...............................8
  insignifica 7
  longipersa...........................26
      var. magma..................201
  mediavia.............................26
  persa..................................26
  plicata................................69
  quercollis............................26
  simpsoni.............................66
  streptophora.........................68
  venusta..............................233
  virgo 230
Pleurotomaria quoyana............164
Plaurotomella agassizi...............68
  blakeana 68
  brevis..................................68
  diomedeæ............................72
  extensa................................68
  filifera.................................68
  hadria..................................68
  incilis..................................69
  leucomata............................67
      var. mexicana...............68
  packardi.............................67
Plicatula densata....................380
  marginata *31*............203, 380
Polinices eminuloides..............148
  fringilla 148
  hemicrypta.........................148
  leptalea 148
  stanislas-meunieri *16*...196, 329
  subclausa *16*............196, 329
  tenuis 147
Pollia 87
Polyschides................................40
Potamides, var gracilior 127
  matsoni.............................127
  satillensis..........................130
Protocardia costaricensis *30*...401
  gurabica *30*........194, 196, 401
  harrisi.................................25
Psammobia harrisi *3*................24
  smithi *3*.............................23
Psammosolen gatunensis, var.
      costaricensis *32*.........432
Pseudoliva scalina.....................26
  unicarinata 26
Pteria inornata *31*..........194, 367
Ptychosalpinx dentalis *18*......187,
      281
Puncturella circularis...............166
  triangulata.........................167

Puncturella trifolium..............166
  watsoni..........................166
Purpura...............................100
  nodulosa..........................101
  nodulosum.......................305
Pyramidella candida...............107
  crenulata..........................107
  dolabrata..........................107
  mitchelliana......................10
  obtusoides *1*.......................10
  smithi..............................107
  thelma..............................108
Pyrula abbreviata...................101
  papyratia..........................119

R

Ranella...............................114
  clathrata............................99
  crassa...............................306
Retusa frielei..........................49
Rhizochilus............................101
Ricinula nodulosa...................305
Rimula.................................167
  asturiana...........................167
Ringicula dominicana.......194, 196, 206d
  hypograpta........................186
  leptocheila..........................47
  nitida..................................47
  semistriata.....................206d
Rissoa acutiocostata................139
  chesneli............................139
  percipitata.........................138
Rissoina alabamensis.................26
  browniana..........................139
  chesneli.............................139
  decussata...........................139
  elegantissima.....................140
  læviqata.............................139
  sagraiana...........................140
Rochefortia minuta *2*................20
Rotella cryptospira..................162

S

Sabatia bathymophila.................50
Sanguinolaria alouata *32*........432
Santo Domingo Miocene...........92
Saxicavella alabamensis *3*........21
Sayella...................................56
Scalaria................................102
Scaphander librarius.................49
  nobilis................................49
  punctostriatus.......................49
  watsoni...............................49
Scaphella costaricana..............187
  costaricensis *18*..................272
  junonia................................81
Scobinella morierei *7*.............251
Sconsia bocasensis *15*............309
  cocleana *15*...................187, 310
  lævigata...................195, 200, 201
    var. gabbi *15*....................308
    zone..................................193
  sublævigata.........................200
Seguenzia.............................158
  formosa..............................120
  iconica...............................121
  monocingulata......................120
  trispinosa............................120
Seila adamsi..........................124
Semele claytoni *32*....194, 196, 431
  lævis..................................191
    var. costaricensis *32*....430
  langdoniana *2*......................18
  monroensis *2*.......................19
  sayi *32*.............................430
Semicassis............................118
Seminella stearnsi....................94
Serpulorbis papulosa *15*...196, 200, 317
  sculpturatus........................200
Sigaretus..............................150
  gatunensis...........................186
  martinianum.........................150
  gabbi..................................186
Siliquaria squamata..................133
  limonensis...........................188
  modesta.......................134, 188

- Siliquaria modesta, var. limonensis *15* 319
- Simnia intermedia..................112
  - uniplicata..........................112
- Sinum maculatum 150
- Sinum minor.............. 150
  - perspectivum........ 150
- Siphonalia quadrilineata *2*........15
- Siphonaria alternata..................58
  - lineolata..............................58
- Siphonium nebulosum.. 133
- Sistrum nodulosum *13*..........101, 190, 305
  - roseum.................. 101
- Skenea planorbis........... 140
- Solariella æglees......................157
  - alabamensis.........................26
  - amabilis 156
    - var. clavata.................157
    - var. iridea...... 157
  - lissoconcha........................157
  - lubrica................................157
  - scabriuscula............... 156
- Solarium gatunense.. 326
  - granulatum 326
  - periscelidum........................26
  - villarelloi 200, 326
- Solecurtus gatunensis..............432
  - strigillatus..........................186
- Solenosteira chiriquiensis *11*...286
  - dalli...... *11*......................285
    - var. medioamericano...200
  - vaughani 200
    - var. medioamericana *11*...............................285
- Spirialis rostralis............... 44
- Spondylus americanus..............379
  - chirquiensis *23*..................378
  - gumanomocon *24*......194, 379
- Strepsidura heilprini........... 25
- Strigilla musanica *29*..............427
  - pisiformis...... .....194, 200, 426
  - pisiformis...............................189
- Strombina ambigua *13*..........298
  - chiriquiensis *13*................302
  - costaricensis *13*...............300
  - cricamola *13*......................299
  - gibberula, var. galvestonensis........ 91
  - lessepiana *13*....................298
  - matima *13*.........................299
    - var. musanica *13*........301
  - sincola *13*............... 301
- Strombus accipitrinus..............120
  - costatus 120
  - gatunensis *16*....... ...188, 313
  - pugiloides *16*.....187, 196, 314
  - pugilis......... ......119, 200, 314
- Styliola... 43
  - virgula 43
- Syrnola smithi..........................107

T

- Tagelus cebus *32*............ 433
- Tapes grus...............................420
- Taranis pulchella 72
- Tectarius muricatus..................137
- Teinostoma cryptospira....... ...162
  - regularis *1*........... 12
  - subangulata, var. smithi *1*...11
- Tellidora cristata *29*........189, 426
- Tellina bellsiana *2*...................17
  - cercadica...... .....194, 196, 425
  - costaricana *29*..................423
  - crystallina *29*..........189, 191, 194, 421
  - cynoglossa..........................17
  - dariena *29*.. 424
  - equiterminata......................186
  - estellensis *2*................17, 25
  - gatunensis... 429
  - leana......................................7
  - lepidota *29*...............200, 423
  - nasua *29*............... 422

rovala *29*....421
rowlandi....424
semilævis....424
semipapyria *2*....18
semirotunda *2*....18
umbra *29*....205, 425
Tenuiactæon pertenuis *2*....16
Terebra benthalis.... 189
var. boscasensis *4*....213
berlineræ *4*....194, 211
bipartita *4*....194, 199, 207
var. bocasensis....189
calhounensis....60
cinera....58
concava....59
costaricensis *4*....212
dislocata....59
estrellana *4*....212
galvestonensis....60
gatunensis *4*....208
gausapata *4*....210
haitensis *4*....194, 207
jamaicensis....58
langdoni....60
limatula....60
lutescens....60
var. midiensis *4*....211
nassula....60
petitii....59
protexta....59
pumbriensis *4*....213
rudis....59
salleana....58
spirifera *4*....194, 210
subsulcifera....207
texana....60
vinosa....59
wolfgangi *4*....208, 209
Teredo ringens *2*....17, 25
Tethys protea....53
willcoxi.... 53
Thais deltoidea....100
hæmastoma....100
var. floriana....100
patula....99
Theodoxus....163
Thracia gastunensis....187
tristani *23*....383
Tonna galea....119
perdix....119
Torcula....134
Torinia canalifera....138
cylindrica....138
Tornatella quercollis....26
Tornatina ovulina....47
coix-lacryma....206b
Tralia denticulata....57
minuscula....57
myosotis....57
pusilla....57
triplicata....57
Trigonostma....74
Triphora abrupta....122
bigemma....122
colon....121
cylindrella....123
decorata....121
hircus....122
inf. var. ibex....122
inflata....122
perversa, var. nigrocincta....121
torticula....122
triserialis....121
Triptera....44
Triton....115
cantrainei....117
lacunellus....99
parvus....88
pulchellus....116
showalteri....26
simillimus....305
Tritonidea....87
Trivia approximans.... 114
candidula....114

Trivia globosa...114
olorina...114
pediculus...113
pilula...114
sphærula...114
suffusa...114
Trochus agglutinans...332
amabilis...156
lenticularis...129
Truncatella bilabiata...142
carinænsis...142
pulchella...142
subcylindrica...143
Turbo albida...153
castaneus...152
crenulatus...153
muricatus...137
pulchella...152
saltus *18*...333
spenglerianus...333
Turbonilla...107
belotheca...108
cedros...110
clinensis *1*...9
conradi...109
curta...109
exilis...108
interrupta...108
obeliscus...109
pumicea...109
reticulata...109
speira...109
styliformis...110
tardiusculus *1*...9
textilis...108
tuscahomensis *1*...9
virga...109
viridaria...108
Turricula lavina...191
lavinoides *7*...191, 227
var. limonensis *7*...228
taurina *8*...229
terryi *8*...229
Turris albida *7*...62, 190, 194, 199, 230
var. tellea...62
bimoniatus *1*,...7
denticulata...6
moniliatus...8
nodoideus *1*...5
specus *1*...6
Turritella acropora...134
alabamiensis...25
altilira *17*...188, 321, 322
var. chiriquiensis *17*...322
var. costaricensis *17*...323
chipolana...135
conradi...320
exoleta...134, 188
var. limonensis *17*...324
gabbi...321
gatunensis *17*...320
humerosa...25
var. limonensis...188
mimetes *17*...321
mortoni...25
oreodoxa *17*...324
satilla...135
subgrundifera...135
terebriformis...135
tennesseensis...25
tornata...323
variegata...134
yucatecana...134
Typhis alatus *13*...195, 304
gabbi...186
linguliferus, var. costariensis *13*...304

U

Ultimus...112
Umbonium bairdi...158
Urosalpinx cinereus...97, 282
floridana...98
perrugatus...97
tampænsis...97

Utriculus 48

V

Vaginella chipolana 43
Vaginula 58
Venericardia conradiana, var.
    limonensis *29*....................389
  scabricostata *35*...194, 200, 388
  terryi *35* 388
  wilcoxensis 23
Venus blandiana....................413
  ebergenvii 200
  maculata....................406
  magnifica....................412
  multicostata.................... 411
  rugosa....................412
Vermetus papulosus....................317
  pulcher....................200
  sculpturatus 318
Vermicularia nigricans....................133
  spirata....................132
Vermiculus spirata....................132
Veronicella floridana....................58
Vitrinella hemphilli....................159
  interrupta....................159
  mooreana....................159
  multicarinata....................161
Voluta alfaroi *11*....................187, 271
  flava....................55
  dubia....................81
  virescens....................81
Volutilithes limopsis 25
  rugatus....................25
Volutella 80
Volvaria....................48
Volvarina....................80
Volvula cylindrica.....190, 194, 199,
    206c
Volvulella micratracta....................186

W

Williami krebsi 58

X

Xancus scolymus....................284
  scopulus *14*....................283
Xenophora agglutinans....................146
  caribæa....................136
  conchyliophora....................145, 332

Y

Yoldia bocasensis *31*....................348
  eborea....................25

Z

Zizyphinus....................154

ADDENDA ET CORRIGENDA

NOTE.—All page references are to the Volume and not the separate Bulletins.

Page	
47	For RNIGICULA read RINGICULA.
58	For *Siphonaria lineolata* d'Orb. (name preoccupied) substitute *S. naufraga* Stearns.
75	For *Oliva circinata* Marrat substitute *O. sayana* Ravenal (Cat. p. 19, 1834) and place *circinata* in synonymy.
77	For *Marginella apicinca* read *apicina*.
81	For *Scaphella junonia* substitute *Maculopeplum junonium*, this species being the type of *Maculopeplum* Dall, 1906.
101	For *Epitomium* read *Epitonium*.
104	*Janthina communis* is regarded by Johnson (Nautilus, 1922) as identical with *J. janthina*. Bartsch, however, considered *communis* and *fragilis* (equals *ianthina*) to be distinct (Bull U. S. N. M. 1915). The latter opinion is followed here.
164	For *Petrotrochus* read *Perotrochus*.
188	For *Chione Rowelli* read *ChioneRowleei*.
206a	After *Acteon costaricensis*, n. sp. insert Pl. 15, fig. 15.
275	For *Fuses miocosmius* read *Fusus miocosmius*.
306	After *Bursa crassa*, for Pl. 15, fig. 15 read Pl. 15 fig. 19.
318	For H. B. Lea read H. C. Lea.
405	For *Gafrarium limonensis* read *Gafrarium limonense*.

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